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For Higher Meeting Values

APPROACH of the meeting of the American Society of Agricultural Engineers in Chicago next month prompts a reanalysis of its purpose in the interest of mutual understanding and continued improvement.

As one ASAE member has put it, "I wonder if it has occurred to very many of our program speakers that, when they take a half hour on our program, they are utilizing from $1000 to $2000 worth of time of those listening. Or, do they realize that it costs about $50,000 for those who attend our meeting to finance the trip?"

How is this cost justified? How can the meetings be made to repay this investment, with interest?

As a means of distributing technical information? No. The papers could be prepared, reproduced, and mailed to a much larger group at a small fraction of that cost. They could be read at leisure and referred to on occasion, as, in fact, they are. It would be the height of inconsistency for advocates of efficiency to try to carry home in their heads a mass of technical details which are easily reproduced and distributed in the exact words of the author.

As occasion for discussion, group thought, and efficient interchange of ideas and viewpoints? Yes. This is an important means of development of agricultural engineers and of advancing their work, and can be accomplished in no other way.

How then should the meetings be planned and conducted; and how should the papers be prepared, presented and discussed, to best accomplish the desired stimulation and interchange of ideas and viewpoints?

A major limitation on the meetings is time. Its efficient use is subject to continual consideration. It dictates the requirement of simultaneous sessions.

Division chairmen have sought to offer, in the time available, as much and as wide a variety as can be adequately presented and discussed, of the available subject matter of greatest evident immediate importance. With the cooperation of the speakers, discussers, and audience, they can and will run their sessions on schedule, leaving time for discussion both in and out of sessions.

By way of economizing on time, and concentrating group thought within its professional boundaries, all papers, reports, and discussion should keep clearly within the technical field of agricultural engineering, except for reference to developments in other agricultural and engineering fields which may reasonably be expected to influence agricultural engineering, and to the possible influence of agricultural engineering in other fields.

As a basis for discussion, a technical paper should be an authoritative contribution; based on a solid foundation of committee work, observation, research, or trained technical thought; relating to work completed, in progress, contemplated, or needed; covering the technical purpose, methods, equipment, results or expected results, their expected significance, state of completion of the work, its relation to other work, plans for further work, and author's conclusions, if any; neatly summarized; adequately annotated as to source material and similar work by others; and clearly illustrated. It should be concise and packed with new information or thought on a new subject, or on an old subject of continuing interest to agricultural engineers.

Things not wanted in papers to be presented before the Society include political opinions, sales propaganda, long introductory histories, explanations of elementary details, and rehashing of facts generally known to the audience.

Remembering that the program is full; that the audience has many other and equally important interests; that the paper will be available to all to read in full; that the audience cannot possibly absorb, understand, and remember all its details from hearing it read; and that the purpose of presenting the paper on the program is to open up the subject thereof for discussion, should the author read it to his audience in full? ASAE members have indicated that they heartily disapprove of this practice. Rather they prefer (1) that he introduce his paper with a brief discussion of the what, how, and why of its main points; (2) that he give them extemporaneously, if possible, or by reading only the parts of his paper important to its discussion; (3) that he refer to it as necessary in the discussion, and (4) that he illustrate his presentation in a way that will add to its clarity.

Subject matter and arrangements for the Chicago meeting are up to the usual high standards. If the chairmen, speakers, and audience start with a mutual understanding of what they are trying to accomplish, and how it can be accomplished, there is no question but what these sessions will set a new high standard of meeting values in the Society.

More About Upstream Engineering

SOME practical considerations of upstream engineering have been well outlined by an agricultural engineer as follows:

". . . . We must recognize that we are dealing with private lands and property, in addition to dealing with millions of individuals. It is therefore necessary that much education be carried on to present clearly what might be known as the 'reasons why' for any proposed action.

"In a project of this kind, local viewpoints and experience are most valuable. It is dangerous to make a general program from a central location on a subject as diversified as this one. It may seem as though local people are unfamiliar with this situation of erosion, destruction of coverage of watersheds, loss of water with attendant depletion of underground water supplies as well as surface water supplies, and the like. I am inclined to think that an investigation in any community thus affected will bring forth people who have given a great deal of thought to the subject and closely observed results of these destructive forces through many years, but owing to lack of facilities or finance, have not been able to do much about the problem. In addition, most of these problems call for group action,

which could not be easily arranged under existing laws or conditions.

"Local people must be willing and anxious to carry forward this program before it can ever be a success.

"I believe, furthermore, that when the proper job of education is under way, there will be much less need for financing and directing from the top, so to speak. The benefit of stream control, water control, all other methods of control of the destructive forces, bring in their wake benefits which are valuable to every local community and thus form the foundation for local financing and support."

A program of organizing, and of improving through continued research, the physical science and equipment for upstream engineering, as a logical follow-up of the recent conference in Washington on upstream engineering, is taken for granted. The matter of putting this science to work on a greatly increased scale involves, as indicated, problems in cooperation, education, and public policy. The first thing to remember in considering any general program to put upstream engineering into effect, is that it must win the approval of millions of land owners.

Subsistence Farming

IF ENGINEERS in their right as citizens, and as a profession whose works influence economic changes, may presume to inquire into economic matters, we would like to consider that theory and phenomenon of extreme economic localism which goes by the name of "subsistence farming."

We hear that it is safe; that the subsistence farmer raises his living and doesn't have to worry about employment, farm prices, or any other kind of prices; also that he is independent.

We had thought that the subsistence farmer and his family were extremely dependent; dependent on themselves and their acres, their strength and ingenuity, aided only by simple tools and power sources, for practically the entire means of their existence. It has seemed to us that the subsistence farmer has a great employment problem; not a problem of where and for how much he should sell his services, but of where, when, and how he can apply them on his farm and within his limitations, effectively enough to produce a living for himself and family. It had seemed to us, too, that a mere existence represented a low-wage return for dawn-to-dark hours of labor, or, in other words, that about eighty hours of hard work per week was a high price to pay for the bread and butter of existence. And as to safety, subsistence farming history provides numerous records of excessive privation due to lean years and weather catastrophies.

It was our impression that somewhere, several thousand years back in the progress of civilization, some two or more people had found that each could produce one or a few products or services better than others, and that by specializing in what they could do best, and trading their surpluses for those of specialists in other lines, both sides of the bargain would gain in quantity, quality, and variety of the means of life and happiness.

It has been our understanding that this practice of trade was a substantial part of the foundation of our present civilization; that our civilization would continue to progress by improvement of trade practices and elimination of their abuses, rather than by stepping back several thousand years or even several decades, to a high degree of subsistence farming as something essentially better.

The right of any individual to try subsistence farming is an essential element of economic independence. Some individuals may always succeed better at it, and be better satisfied with it, than with any other mode of life. But we fail to understand how that supports it as a foresighted policy for agriculture, or even as a buffer to ease the shock of temporary slack periods in urban employment.

Air Conditioning in Agriculture

To the Editor:

IN VIEW of the suggestion made regarding "air conditioning" in the editorial, entitled "Air Conditioning in Agriculture," appearing in AGRICULTURAL ENGINEERING for July, you might be interested to learn of the efforts in this direction which are being made by the Bureau of Agricultural Engineering in cooperation with the departments of agricultural engineering of the University of Wisconsin and the University of Georgia.

Tests are being conducted at present near Madison, Wisconsin, and near Athens, Georgia, which it is hoped will result in findings of value in making farm homes more comfortable both in winter and summer.

The first step is to obtain comprehensive information on temperature, air movement and humidity conditions, as they actually exist in average farm homes, and the factors responsible for these conditions. It is then our purpose to devise means of eliminating or modifying those conditions which are undesirable, and reproducing in other structures those which are desirable.

In the experimental house which has been erected at Athens, Georgia, removable wall sections make it possible to conduct tests of various types of wall construction and insulation. Windows and doors can also be shifted in order to ascertain the location at which the most effective ventilation can be obtained. In addition, by raising and lowering the roof, the proper ceiling heights can be determined.

The object is to achieve "air conditioning" through structural rather than mechanical means, and at the lowest possible cost to the home owner.

We are attacking the problem from this angle because we feel that even if, as suggested in your editorial, mechanical air conditioning equipment were produced to sell at a comparatively low cost, it would still be out of the reach of a large percentage of farmers.

The technique for these studies of comfort in the farm home has been developed in large part through studies of structures for livestock and crop storage. It is hoped that the studies of farm homes will in turn contribute to the solution of problems related to maintaining proper environmental conditions in the other types of farm buildings.

WALLACE ASHBY

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New Developments in Fertilizer Placement Research

By G. A. Cumings

THE RESEARCH program dealing with fertilizer placement is only one phase of the present extensive investigations pertaining to the utilization of commercial plant food. These investigations have been materially expanded and coordinated during the past year, which is an advance in agricultural research believed to be amply justified because of the inevitable increased use of commercial fertilizer and the relatively low fertilizer efficiency apparently obtained from the large tonnage now consumed. Although much intensive work on various phases of the problem is in progress particular attention has recently been directed toward such considerations as fertilizer ratios and reactions, symptoms of malnutrition in plants, rapid methods of determining soil deficiencies, and most effective methods of fertilizer application.

Placement of fertilizer became an essential factor with the introduction, a few years ago, of more readily soluble plant food materials with which well-defined methods of application were required to avoid possible early injury to the seed or seedling. Extensive investigations of machine placement of fertilizers were inaugurated largely through the influence of the National Joint Committee on Fertilizer Application composed of representatives of five parent organizations. The organization of the joint committee, of which C. O. Reed of this Society is general chairman, was recently described in AGRICULTURAL ENGINEERING for April 1936, and the March issue of the Fertilizer Review. Because of the complex nature of the fertilizer application problem, and the numerous interrelated factors and conditions involved, research studies are conducted very largely by cooperative effort of the various agencies concerned.

Experiments have also been widely distributed in order that the scope of present fertilizer application practice might be covered to an appreciable extent. In one area or another commercial plant food is now supplied to practically every crop grown in the United States and applied on all major types of soil. The amount of fertilizer ordinarily used varies widely with different crops and existing conditions and ranges from less than 100 to more than 6,000 pounds per acre. It has been reliably estimated that the consumption of commercial fertilizer on more than two million farms throughout the United States during 1936 will closely approach 7,000,000 tons, with a value of approximately $175,000,000.

Fertilizer placement experiments on which reports have been presented to the joint committee were conducted during the past year with 13 crops at 49 locations in 16 states. The following agencies formally cooperated in this experimental work: The U. S. Bureaus of Agricultural Engineering and Plant Industry, the National Joint Committee on Fertilizer Application, the National Fertilizer Association, and agricultural experiment stations in Georgia, Indiana, Louisiana, Maine, Maryland, Michigan, Mississippi, New Jersey, New York, North Carolina, Ohio, Oklahoma, South Carolina, Texas, and Virginia. Progress reports presenting the findings of the various studies in considerable detail have been assembled in the Proceedings of the Eleventh Annual Meeting of the National Joint Committee on Fertilizer Application, which was published and distributed by the National Fertilizer Association, Washington, D. C. The above-mentioned research program does not include a number of independent studies directly related to methods of fertilizer application. As a further review of the developments in mechanical placement of fertilizers which were reported in AGRICULTURAL ENGINEERING for October 1935, this paper will be confined to a discussion of the new research studies and other activities of the past year.

The results of the 1935 experiments in general indicate that fertilizer is of greatest benefit to the crop when applied in a band at each side of the row. A placement approximately 2 inches to the side of the seed or plant and about 3 inches below the surface of the ground was the superior treatment in most cases. The most effective location of the

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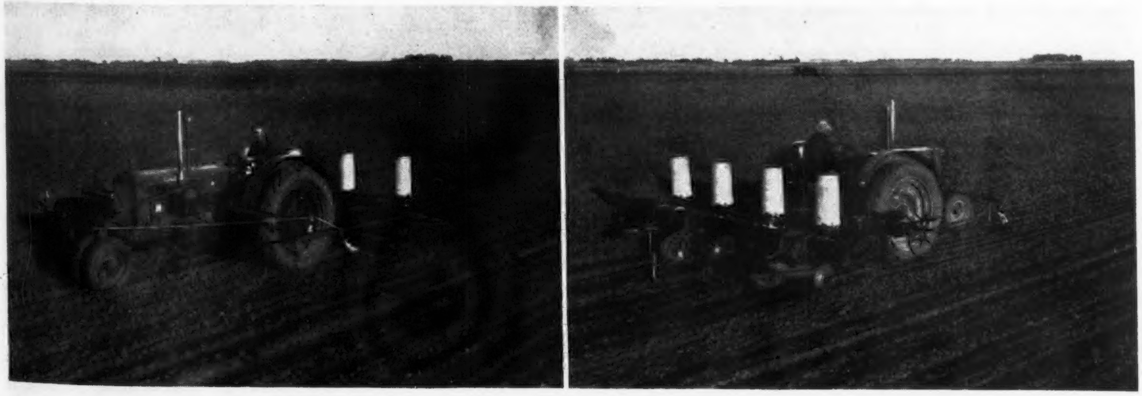


MODERN FOUR-ROW, CHECK-ROW TRACTOR PLANTERS WITH FERTILIZER DISTRIBUTORS WHICH PLACE THE FERTILIZER IN NARROW BANDS ON EACH SIDE OF THE SEEDS, WHERE IT DOES THE MOST GOOD

fertilizer band at the side of the row differed somewhat with the crop, soil, and weather conditions, and the amount of fertilizer. Fertilizer placed directly under the seed or plant, either in a band or mixed with the soil, in most cases caused early injurious effects which were reflected in the yields. Fertilizer applied broadcast in a limited number of experiments was in all instances decidedly inferior to comparable placements at the side of the row. These general trends are in line with those observed in preceding studies.

Methods of fertilizer application for several crops, including corn, cotton, and potatoes, have been studied for several years, and the findings are doubtless known to most agricultural engineers. In discussing the more recently inaugurated studies some typical results on an acre basis will be given to show the magnitude of crop differences obtained in 1935 with representative fertilizer placements. Fertilizer placement, unless otherwise mentioned, indicates the amount of fertilizer-free soil interposed between the fertilizer and the seed or plant.

At Geneva, New York, the highest yield of wax beans was 3,898 pounds with 300 pounds of fertilizer placed in a band 1.5 inches to each side of the seed and only 2,706 pounds with the same amount of fertilizer placed 2 inches under the seed. Double the amount of fertilizer applied broadcast gave 3,040 pounds of beans. The results definitely indicate that broadcasting fertilizer in farm practice under these conditions would result in exceptionally low fertilizer efficiency. The same relative standing of treatments and similar crop differences were obtained with lima beans at Norfolk, Virginia. No conclusive trends were noted in studies with white beans in Michigan under the existing conditions except the adverse effects of fertilizer when placed in the furrow with the seed.

Investigations have indicated that yields of transplanted crops differ materially according to the placement of the fertilizer. The average yields of tobacco for three experiments located at Tifton, Georgia; Florence, South Carolina; and Oxford, North Carolina were valued as follows: Local practice, of drilling the fertilizer in the row, mixing with the soil, and ridging, $301; fertilizer placed in a band 2.5 inches to each side of the row, $331; a band 1 inch under the plant, $216; mixed with the soil in the root zone, $268; and placement at the sides of the row, but two-fifths of the fertilizer being applied three weeks after transplanting, $351. A precise placement of the fertilizer in a band at each side of the row, whether the entire application is made at time of setting the tobacco plants or a portion of the fertilizer is applied as a side dressing, appears to be of definite advantage. The highest yields of both cabbage and tomatoes were produced with fertilizer placed 2.5 inches from the row, in experiments in New York and Virginia where methods similar to those with tobacco were employed. The possibilities of further increasing fertilizer efficiency were indicated with tomatoes at Geneva, New York, where hill applications in a 15-inch band at each side of the plant produced 4 per cent larger yields than did continuous bands.

EXPERIMENTS WITH NARROW-ROW CROPS

Previous fertilizer placement studies have been confined to the more widely spaced row crops. Experiments inaugurated the past year with cannery peas and spinach are of particular interest because these crops are grown in closely spaced rows. The experiment with cannery peas was conducted at Geneva, New York, where the grain drill is commonly used to plant the seed and the fertilizer is ordinarily applied in the furrow with the seed. The results of this experiment have been published in New York State Agricultural Experiment Station Bulletin Number 659. Under the conditions of this experiment with a 7-inch row spacing, 300 pounds per acre of a 4-16-4 fertilizer applied in the furrow with the seed seriously reduced the stand of plants which resulted in a yield of 935 pounds of vined peas per acre. A yield of 2,246 pounds was obtained without fertilizer. Yields from applications in a band at one side of the row were as follows, according to the horizontal distance from the center of the row to the center of the fertilizer band: 1.5 inches, 2,401 pounds; 2.5 inches, 2,877 pounds; and 3.5 inches, 2,274 pounds. Precision in placing fertilizer, even in relatively small amounts, to a sensitive crop such as peas evidently is essential.

Marked effects of fertilizer placement on spinach grown at Norfolk, Virginia, in rows spaced 8 inches apart were noted. Germination and seedling growth were greatly retarded where the fertilizer was placed under the seed.

Numerous significant points observed in the studies with the various crops in different states cannot be specifically mentioned in this brief account of recent findings. For example, side placement was superior for cotton and a band of fertilizer at only one side was equally as effective as a band at each side of the row. Hill application of fertilizer for potatoes with the common spacing of the seed pieces showed indications of advantage in certain instances. Placement of fertilizer above the seed as accomplished with certain attachments for grain drills was not advantageous with peas under the prevailing conditions. Residual effect of fertilizer applied the preceding season along widely spaced rows did not cause uneven-maturity and inferior quality of cannery peas to which fertilizer was properly applied. With lima beans, residual benefits were greater where fertilizer was previously confined to each row, than where broadcast.

REASONS FOR POSITION ADVANTAGES

The present research program has brought out a few indications as to why fertilizer is of greatest benefit to the crop when placed in certain definite positions. The trends observed in the experiments conform to logical reasoning based on present knowledge of physical and chemical changes which take place after fertilizer is deposited in the soil. It is beyond the scope of this paper to trace the changes and chemical reactions through their various stages. However, the following general statements of certain effects may be of interest in this connection:

Fertilizer is of little benefit to the crop except in the presence of adequate moisture.

Some seedlings are apparently stimulated by the fertilizer even before they appear above ground, which has been frequently indicated by fewer plants emerging when no fertilizer is applied.

Early injury is caused mainly by too great a concentration of fertilizer salts in the soil solution surrounding the seed or plant roots. The concentration of the soil solution varies inversely with either the amount of soil moisture or the time elapsing after the fertilizer application, and directly with the amount of fertilizer. Experimental results indicate that from ten to twenty days is usually required under average conditions for relatively large amounts of fertilizer to diffuse in the soil to a point where the concentration of the soil solution does not adversely affect the plant. The degree of concentration required to cause injury is not the same for all crops. Some injury may be caused by the toxicity of certain materials.

The soluble fertilizer salts are diffused in the soil as they move with the soil solution. Movement, which is much greater vertically than horizontally, starts immediately if sufficient moisture is present. Due to leaching in loose-

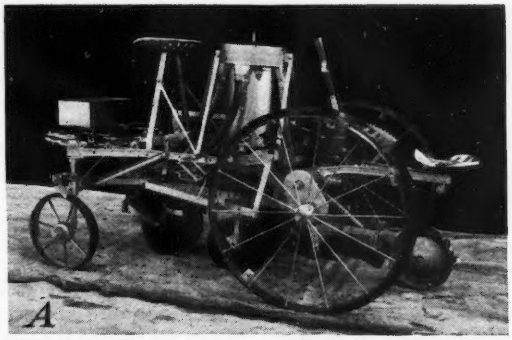
textured soils, a portion of the soluble fertilizer materials may be carried out of reach of the plant.

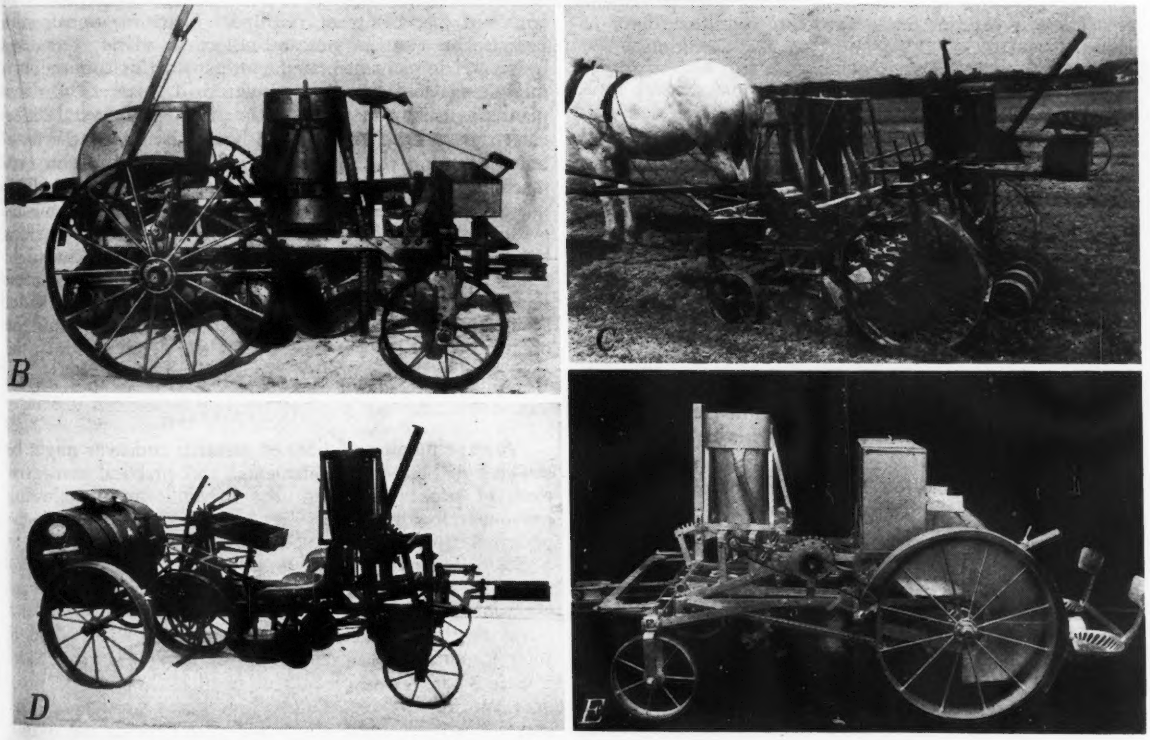
Chemical reactions in some soils make certain plant food elements unavailable to the plant. Such reactions are at a maximum when the fertilizer is widely distributed and in intimate contact with the largest possible amount of soil.

In view of the above-mentioned processes, fertilizer placed in appreciable amounts in the furrow with the seed, or either closely under or above the seed or seedling roots, is very likely to have some immediate injurious effects. If the soluble fertilizer salts are not carried into contact with the seed, the seedlings, within a few days, will reach the fertilizer whether above or below. Heavy rainfall at the proper time dilutes the soil solution to such an extent that the possibilities of fertilizer injury are materially decreased. On the other hand, severe injury is usually noted with little or no rainfall for 2 or 3 weeks following fertilizer application.

Mixing of the fertilizer with the soil in the row is hazardous unless the fertilizer is either well distributed around the seed or seedling or is applied a week or two in advance of planting. This method has been very generally used in the past, but without due precaution it is questionable in many cases because of the uncertainty of definite placement of the fertilizer with respect to the seed or seedling. The thoroughness of the mixing depends to a great extent on the condition of the soil and the design of the mixing tools. If the planting of the seed is accomplished in a separate operation, the relative placement of fertilizer and seed may not be definitely and uniformly controlled. This method of application when improperly used has frequently resulted in serious early injury to the crop under adverse moisture conditions. Furthermore, placement of fertilizer under the seed at time of planting either in a band or mixed with the soil necessitates depositing the seed in disturbed soil, the capillarity of which is broken. The percentage and rapidity of germination has been lowered in many cases where the seeds were deposited in loose soil.

Fertilizer applied broadcast usually has no serious early adverse effects on the crop, although such effects have been observed in the experimental work with crops of low fertilizer tolerance. Material loss of certain fertilizer elements, particularly phosphorus, through fixation with certain types of soil has been observed with broadcast applications. It is also quite obvious that the possi-





Special fertilizer-placement equipment: A, for cotton; B, for potatoes; C, for spinach; D, for tomatoes and cabbage; E, for tobacco. The special machines built solely for experimental work are typical of those used by the U. S. Bureau of Agricultural Engineering in cooperative fertilizer placement studies. The fertilizer hopper is of the positive-action, top-delivery type with which quantity adjustments are determined mathematically and fertilizer is dispensed through one or more tubes in any fractional portions of the total delivery desired. The soil working tools, except the seed covering device, are mounted rigidly on a non-inclining horizontal subframe to insure uniform relative placement of fertilizer and seed. Provision is made for attachment in various positions of interchangeable furrowing tools and fertilizer placement devices. Fertilizer hilling devices are also provided for those crops grown in hills. Bedding disks return the disturbed soil to the row to permit uniform planting with all treatments. Wheel flanges reduce lateral slippage and contribute to increased traction as well as uniform wheel travel

bilities of the leaching of soluble salts would be greatest with broadcast applications. Materials not readily soluble which are applied on or near the ground surface may not be within the reach of the plant until worked into the soil or otherwise covered to a sufficient depth. Root development is often restricted in the surface soil either by lack of moisture or frequent disturbance in cultivating the crop.

Proper placement of fertilizer in a narrow band at either one or both sides of the row whether continuous or in short bands at the hill obviates some of the difficulties encountered with the methods above mentioned. Since the soluble fertilizer salts do not move much laterally, there is practically no possibility of early injury to the seed or seedling. Tap roots, some of which extend downward several inches before the seedling appears above ground, do not encounter a high concentration of fertilizer salts. If the fertilizer is at a depth to insure the presence of adequate soil moisture under usual conditions, it will be in the path of the main lateral root system of most crops. By the time the lateral roots reach the fertilizer band the soluble fertilizer has diffused in the soil sufficiently to prevent damage. The possibilities of leaching and of fixation of fertilizer constituents are reduced by confinement of the fertilizer to a limited zone in the soil. Furthermore, it is not necessary to disturb the soil under the seed.

There are exceptions to the above general statements particularly under conditions of heavy rainfall and small applications of fertilizer. No particular fertilizer placement has been invariably the best, but certain placements have been rather consistently superior. Some questionable placements not definitely inferior under favorable conditions have resulted in severe crop losses under adverse conditions.

EQUIPMENT FOR ADVANTAGEOUS PLACEMENT OF FERTILIZER

There has been progress toward the development, adoption, and use of improved equipment for advantageous placement of fertilizer. This advancement during the past year, so far as known, has covered very largely the refinement of devices recently developed and the more widespread use of the improved machines. Planting machines equipped to place the fertilizer in a band at the side of the row especially for corn and potatoes have been available for several years, but the improved fertilizer placement feature has been given increased attention and adopted more generally. The recent side placement equipment for beans and cotton has been adapted to wider ranges of conditions and is in more general use with considerable evidence of satisfactory results.

Increased attention has been given to side-placement fertilizer depositors for transplanters, on the part of both the farmer and the machinery manufacturers. At least one additional make of transplanter has been equipped during the past year to apply the fertilizer at each side of the row. The equipment is located behind the transplanting unit on the machine and thus deposits the fertilizer after the plants are set.

In farm practice where fertilizer is ordinarily applied in a separate operation different procedures have been more generally followed which result in a side placement of the fertilizer when the seed or plants are deposited. Suitably equipped fertilizer distributors and fertilizing planters with the planting mechanism out of gear, have been used to apply the fertilizer in two parallel bands, form a bed over the fertilizer and mark the center of the row. Either seed or plants could then be satisfactorily placed between the fertilizer bands. In other instances, the fertilizer is applied in the mark and separate bedding operations are controlled to place the center of the bed 2 or 3 inches to one side of the fertilizer, in which case the planter or transplanter is then centered on the bed as usual.

In certain areas where grain drills are employed to plant crops such as peas which are susceptible to fertilizer injury, there has been considerable demand for equipment to place the fertilizer at the side of the row rather than in the furrow with the seed as ordinarily accomplished with present standard equipment.

With regard to various vegetable crops grown in closely spaced rows, there have been numerous inquiries concerning planting equipment provided with approved fertilizer depositors. Although some small machines on this order are available, larger multiple-row units commonly used by commercial growers have not been adapted to general farm use. When we consider the operation of closely spaced planting units and the required accurate and shallow coverings of many kinds of seeds, it is quite obvious that the use of additional soil-working tools to place the fertilizer at the desired depth in the soil would be subject to difficulties not encountered with widely spaced units. However, the mechanical problems are not believed to be insurmountable.

A recent development of significance is field demonstration of the influence on various crops of different methods of fertilizer application. Interest has been stimulated in this activity through a more widespread dissemination of information on fertilizer placement. The extension service in several states has undertaken field demonstrations of approved placements of fertilizer. Demonstrational work has also been carried out and otherwise actively supported by several implement manufacturers. In this connection it might be stated that a particular drill, planter, or transplanter is usually adaptable to the planting of several different crops and the question has been raised as to the feasibility of using the particular fertilizer depositor on each machine for the various crops that might be planted. This question cannot be definitely answered because experimental evidence is available only for a limited number of crops but present trends indicate that such an arrangement might not be particularly objectionable provided the placement selected was in accordance with the findings to date and a satisfactory depth of the fertilizer in the soil could be obtained in all cases irrespective of the depth at which the seed or plants are deposited.

CONTINUING RESEARCH

A large number of lines of research endeavor might be pursued in both the fundamental and practical considerations of proper fertilizer use. In addition to following previously inaugurated studies to a logical conclusion, the present fertilizer placement program has been extended to additional crops and conditions. Also the possibilities of increased efficiency by reducing contact of the fertilizer with the soil through hill applications, single bands, and larger fertilizer particles are being explored. The National Joint Committee on Fertilizer Application has undertaken a nationwide survey of present fertilizer application practices and of the distributing equipment available. This survey has been divided into four parts which are related but conducted independently. Three parts cover the following groups of crops: field crops, truck crops, and fruits and nuts, while the fourth covers distributing machinery on the market. This survey is well under way and on completion, definite information will be available to serve as a basis for the most intelligent and systematic planning of future activities pertaining to methods of fertilizer application.

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Tractor Engine Lubrication under Low Temperature Conditions

By E. A. Hardy

THE FARM TRACTOR in western Canada is subjected to severe operating conditions which result in serious cylinder and ring wear. Loss of compression, excessive oil consumption with low efficiency and lack of power are the symptoms which indicate this condition of the engine. The detailed condition of the cylinders, pistons, and rings varies with different engines and operating conditions. The rings may be worn thin, the cylinders worn, the rings stuck in the grooves with carbon or the top ring groove may be badly worn, resulting in excessive side clearance for the ring in the groove.

The engines are usually overhauled in the simplest way. New rings in some, overwidth rings in the top grooves in others. New liners, pistons, rings, and pins where the wear is excessive. Or where liners are not replaceable, the cylinders are rebored and fitted with new oversized pistons, rings, and pins.

Piston ring and cylinder wear has been in excess of wear on the rest of the engine. Soft cylinders and rings have been suspected and blamed but with no real assurance. Dust has been blamed with the result that air strainers have been added and improved with remarkable results. Oil filters have been designed and added with improved lubrication. Generally the engine has been sealed from the dust by main bearing felts, breather air strainers, crankcase redesign, and ventilation, in order to eliminate field dirt and dust as completely as possible from the engine. When tractors are operating in particularly dusty conditions the air strainers are conditioned twice each day, and the oil is strained through heavy canton cotton each day. With all of these precautions the wear due to dust is reduced to a minimum.

Fuel dilution of the lubricating oil has been blamed for the wear, resulting in redesign of manifolding in such a way as to vaporize all or as nearly all of the fuel as possible, to facilitate complete combustion and thus reduce the dilution of lubricating oil. The cooling systems have been redesigned to provide uniform cooling and a more sensitive temperature control of the engine by means of a thermostat and a radiator curtain. Some tractors have been fitted with a motormeter to indicate the temperature of the cooling water, which is necessary for intelligent temperature control by the operator. All such improvements have made it possible to more nearly approach the ideal in engine lubrication and a relative reduction in cylinder and piston ring wear.

Tests conducted at the University of Saskatchewan on both the Massey-Harris and Hart-Parr tractors show the variations in oil dilution for various fuels used.

The temperature of the oil in the crankcase of the average tractor is not high enough to drive off much dilution. Consequently many tractors are operated with oil diluted excessively with fuel ends. For many years observation seemed to indicate that oil diluted quite badly with fuel lubricated satisfactorily as judged by power efficiency and engine wear. These observations have been substantiated by research conducted by the British Institution of Automotive Engineers in 1930. A single-cylinder engine was used with a 3.37-in bore and stroke, operating at 1600 rpm with an absolute mean effective pressure of 59 lb per sq in. Where clean oil was used the oil was diluted with kerosene to 90 per cent before wear increased on the cylinder, or on the top piston ring. The research also showed that even when silica dust, which had been sifted through a 200-in mesh was added at the approximate rate of 8.5 grams per 100 hr to the air which was passing through the carburetor and into the engine, that cylinder or top ring wear was not increased until after a dilution of 75 per cent was obtained.

Consequently, where the oil is kept clean and free from dust, diluted oil does not produce excessive cylinder and piston ring wear. We have been using the oil consumption of the engine as a guide as to the amount of dilution. There are times, of course, where an engine is operating on a fuel which it will not burn satisfactorily, resulting in a rapid accumulation of fuel in the crankcase. In such cases the engine will smoke abnormally, indicating excessive oil dilution and high oil level in the crankcase. The fuel or operating conditions must be changed immediately in order to have satisfactory operation.

There were engines which from all indications were operating under almost ideal conditions and yet were subject to excessive wear. The indications seemed to point to insufficient oil in the pistons, cylinders, and rings. Consequently, a study of oil temperature and viscosity was conducted.

Viscosity of Oil for Tractors. A study of the instruction books for the various tractors indicated that an SAE 40 oil was most commonly recommended as the correct grade for the farm tractor. Some companies recommended SAE 50 and SAE 60 oils, while one or two recommended SAE 20

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FUEL AND OIL TESTS

Brake: "Froude" hydraulic Belt: 100-ft rubber

Engine	Fuel used	Gravity, API	Index No	Av. hp	Fuel per hp-hr, lb	Tmp. of oil deg F	Oil dilution, per cent	Oil used, viscosity
Massey-Harris 26-41	Dist Imp	44.3	2586	30.6	0.74	147	2	SAE 20
Hart-Parr 18-28	Gas	67.4	1447	26.9	0.768	142	1	" "
" "	Kero	40.5	2439	24.93	0.763	152	2	" "
" "	Dist Hi-Way 44	43.9	2431	26.31	0.786	170	2	" "
" "	BA Dist	43.0	2639	26.0	0.771	160	1	" "
" "	Silver Flash Dist Hi-Way 40	41.1	2809	25.71	0.756	162	1.25	" "
" "	Dist	44.6	2573	26.6	0.803	154	1	" "
" "	Imp Dist Hi-Way 35	33.9	3274	25.9	0.782	154	2.5	" "
" "	Dist Hi-Way 40	41.1	2809	25.16	0.780	162	1.5	" 40

and SAE 30 oils. It was difficult to account for the variations in recommendations when studying the design and action of the lubrication systems of the tractors. It was found that generally the tractors in western Canada operate at quite low temperatures for the larger part of the field and belt work. The temperature of the oil seldom gets warmer than 150 deg F during the spring and early fall, nor warmer than 120 to 130 deg in the late fall.

During the operating time during midsummer when the tractor is used for summerfallowing, the temperature of the crankcase oil varies with the design of the engine and work being done, from 150 to 180 deg. Temperatures above 180 deg are practically never found. The crankcase temperature of the average automobile operating at from 40 to 45 mph during the same seasons will run somewhat higher, from 130 to 165 deg in the spring and fall and from 185 to 240 deg during midsummer. The operating viscosity for the automobile engine using an SAE 20 oil in city driving is approximately 160 seconds Saybolt, while on long trips it drops to from 50 to 60 seconds. The operating viscosity for the average farm tractor in the spring and fall using SAE 40 oil averages 380 seconds Saybolt, and during the heat of summer, 130 seconds. The higher operating viscosity tends to lower the efficiency of the engine due to greater internal resistance and also tends to reduce the mist available for piston ring and cylinder lubrication. It is true that the oil becomes diluted more or less rapidly as the engine operates, particularly when operating cold and using distillate. The operating viscosity in many tractors lowers to that of the automobile and frequently lower. However, there is a considerable period where the oil is too viscous for the most efficient distribution of the lubricant.

George Ellis, an Australian engineer, has estimated that 70 per cent of engine wear occurs during the period of no lubrication. The period of no lubrication varies with the engine and the temperature of the oil from 10,000 to 50,000 crank revolutions. This may mean from 10 to 50 min of tractor operation before the engine and oil are adequately warmed up to provide lubrication.

Research by the British Institution of Automotive Engineers indicated that "delayed warming up, particularly if accompanied by scanty lubrication, resulted in a marked increase in cylinder wear." It was concluded that low cylinder wall temperature was the main cause of high wear. The report of the effect of low cylinder wall temperatures upon cylinder and ring wear reads as follows: "An engine was run continuously with cold jackets, the cylinder wall temperature being of the order of 50 deg C (122 deg F). The wear observed under these conditions was very much greater than that obtained at normal operating temperatures. The rate of wear at 50 deg C was approximately eight times that at 100 deg C."

Alcoholic Blends. Organic acids, such as formic and acetic, result from oxidation of alcohol, so that it would be anticipated that the addition of alcohol to a fuel would tend to cause higher cylinder corrosion at low operating temperatures. Tests were run with results as follows:

Fuel	Wear in inches per 1000 miles Cylinder	Top piston ring
Petrol	0.00044	0.0027
Alcohol blend (17 per cent)	0.00080	0.0052
Petrol	0.00045	0.0024

Brake mean effective pressure, 59 lb per sq in; cylinder wall temperature, 50 deg C (122 deg F).

The foregoing results emphasize the necessity for rapid warming up when alcohol blends are used, and appear to indicate that the greater wear obtained at low-operating temperatures is due to the action of organic acids.

The following results were obtained where the engine was run at fairly high cylinder wall temperature, 170 deg (338 deg F):

Fuel	Wear of top piston ring, in inches per 1000 miles
Petrol	0.00032
Alcohol blend	0.00032

It will be seen that the piston ring wear at high operating temperatures was the same on the two fuels, a result which would be expected if corrosion no longer plays a part at such temperatures.

Whether wear during the warming-up period of engine operation is due to condensation of water from the exhaust gases, formation of organic acids, or shortage of oil is difficult to determine. It has, however, been established through years of experience in western Canada that the addition of a small amount of a well-refined lubricating oil to the gasoline will reduce the cylinder and ring wear. One pint of an SAE 20 or 30 oil, added to five gallons of gasoline which is used when starting the engine, protects the cylinders from the water condensed from the exhaust and supplies the much-needed oil during the warming-up period. This practice was confirmed by research on value of upper cylinder lubrication conducted by the British Institution of Automotive Engineers, when 2.2 per cent of crankcase lubricant was added to the petrol and the rate of wear was reduced in the approximate ratio of 3 to 1 for top ring wear and 4 to 1 for cylinder wear, as compared to operation without the top lubrication.

The farm tractor is designed with two fuel tanks, one for starting gasoline, and one for fuel for operation. The starting tank is frequently too small for adequate operation throughout the warming-up period, but is used to advantage for the gasoline-oil mixture for starting.

Zero and Subzero Lubrication. The most severe operating conditions are met where the combine engine or tractor engine are being operated during the fall and winter, during zero or subzero weather. Difficulty in starting is usually overcome by the use of lighter oils and even *(Continued on page 470)*

TRACTOR CARE UNDER ORDINARY WEATHER CONDITIONS IS SIMPLE COMPARED WITH CARE UNDER SUBZERO CONDITIONS WHICH MAGNIFY PROBLEMS OF WARMING UP, CRANK CASE TEMPERATURE, UPPER CYLINDER LUBRICATION, OIL DILUTION, AND ACID PRODUCTS OF COMBUSTION

New Developments in Sugar Beet Machinery

By E. M. Mervine and S. W. McBirney

EXPERIMENTAL work for improving sugar beet machinery was originated and is being continued by a number of agencies for three reasons: (1) Large amounts of hand labor are necessary to grow the crop and production costs are therefore high, (2) hand labor is required in two very distinct and comparatively sharp seasonal peaks, and (3) there is an imminent shortage of sugar beet labor and has been even during the recent years of extreme unemployment.

Numerous studies have been made to determine production costs and labor requirements of different crops, sugar beets among them. Recent figures from California, where sugar beet production is on a large scale, show that 75 man-hours per acre are required to grow the crop. Of this, 36 per cent is for thinning and hoeing in the spring and 33 per cent is for topping and loading at harvest time, or a total of 52 man-hours of contract labor per acre. These figures are probably below the average for the entire United States.

There is, of course, a more or less uniform labor requirement for seedbed preparation, planting, cultivation, irrigation, and harvest, but the large demand for sugar beet labor comes in the spring for thinning and hoeing and in the fall for topping and loading. In California where the thinning and harvest seasons are comparatively long, these labor peaks are high and that in the spring is especially sharp. This means that large crews of men are necessary for comparatively short periods and must find other work or lie idle for considerable time. In the other sugar beet sections where the thinning and harvest seasons are shorter, the labor peaks are even sharper, and the situation would be worse if it were not for the diversification of crops.

Near labor shortages occurred in California last fall during sugar beet harvest and this spring during thinning. In other sections much of the beet work is done by the grower's family or by other white labor. In California, family labor represents a negligible part of that used for thinning, hoeing, topping, and loading the crop. The work is done under contract, largely by Mexicans and Filipinos. It is expected that many of the latter will take advantage of the free transportation to the Philippine Islands provided by the government.

The experimental program of the Bureau of Agricultural Engineering and cooperating agencies on sugar beet machinery, has chiefly been aimed at the reduction of these two seasonal labor peaks. It has consisted largely of work on equipment for hill planting, mechanical blocking and thinning, harvesting, and some special problems or practices which have developed, particularly crust breaking at seed germination time and bed or ridge planting.

The usual practice of growing sugar beets is to drill the seed in a continuous row at a rate of 18 to 20 lb of seed per acre. After the seedlings are up and well established, they are thinned to single plants usually at about 10 or 12-in intervals. On an average stand the thinning operation reduces the number of seedlings in a hundred inches of row from between one and two hundred to about eight or ten.

The planting of sugar beets in hills was suggested as it would have advantages over the usual practice. It should reduce the spring labor peak by eliminating blocking from the blocking and thinning operation. It would save seed, thereby decreasing production costs. The 20 lb of seed usually used costs $3.20 at the present price of 16 cents per pound. Hill planting, requiring 7 to 8 lb of seed per acre, would not cost over $1.28, resulting in a saving of nearly $2 per acre. Hill planting should also result in a more uniform stand which would tend to increase production. It is thought that perhaps fertilizers could be used more advantageously with beets in hills. It is also thought that hills of beets could more easily break through soil crusts which often form following rains at germination time.

The Bureau of Agricultural Engineering, working with the California and Colorado agricultural experiment stations, began experimental work on a hill planter for sugar beets about four years ago. It was known that beet seed dropped irregularly because of its roughness and its low weight of 18 to 19 pounds per bushel. One commonly used planter with a celled seed plate drops bunches of seed on 7-in centers, yet the seed actually reaches the furrow in a more or less uniform drill. It was thought that the difficulty which would be encountered in building a hill planter for the crop would be to get compact hills.

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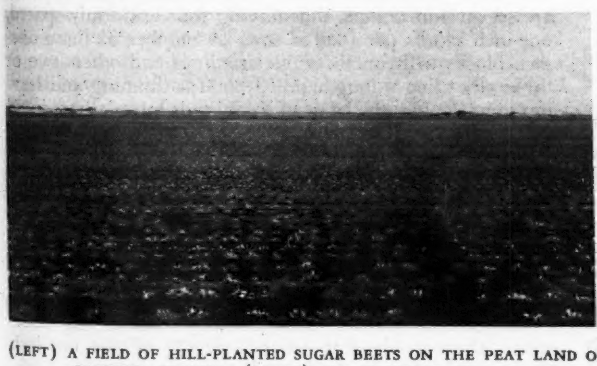
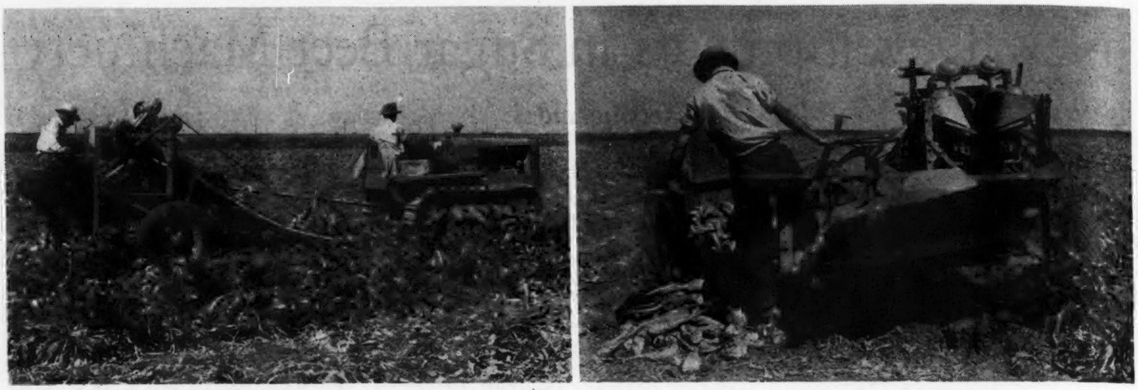


(LEFT) A FIELD OF HILL-PLANTED SUGAR BEETS ON THE PEAT LAND OF THE SACRAMENTO RIVER DELTA JUST BEFORE BEING THINNED, SHOWING BLANKS. (RIGHT) BED PLANTING OF SUGAR BEETS NECESSITATES THE DEVELOPMENT OF NEW EQUIPMENT



(LEFT) SUGAR BEET HARVESTER SUCCESSFULLY HANDLING A 22 TO 25-TON PER ACRE CROP. (RIGHT) TOPPING OF THE BEETS WAS EQUALLY AS GOOD AS HAND WORK

Some experimental work had already been done at Ames, Iowa, on a hill planter using a corn planter type mechanism for sugar beets. It was found that the flapper valves would only work up to about 90 times per minute. This speed would give 23.5-in hills at 2 mph (miles per hour) forward travel of the planter. Sugar beets are desired at 10 to 12-in intervals, sometimes closer. It was therefore decided to use a seed plate acting as a rotary valve for the hilling mechanism. One-row models were designed and built using a seed plate in a vertical plane. Seed cells in the circumference of the plate accumulated seed as they passed through a seed hopper, carried the seed downward, and discharged it near the bottom of the opened furrow. The peripheral speed of the seed plate was approximately equal to the forward travel of the planter and as the plate turned in the direction of forward travel, it virtually functioned as a wheel running on the ground, though it was power-driven. The seed in the cells therefore was practically stationary with respect to the ground at the time of discharge and as the drop was only an inch or two, there was practically no seed scatter. Both roller and plunger seed ejectors were used on different models to effect positive dropping of the seed. After a satisfactory mechanism was developed, units were constructed to use on a field planter and experimental plantings were made.

The farm machionery industry has also been experimenting with hill planters for sugar beets during the past few years and a number of machines have been built. Two manufacturers now have hill planters for sugar beets on the market. One of these had five machines in California last season. Experimental plantings were made with these planters and with the planter developed by the Bureau and its cooperators. Stand counts and thinning studies were made on these plantings.

It was found that beets could be satisfactorily planted in hills with either type of machine. The planter which had been developed by the Bureau gave especially compact hills. This compactness of hill was noted on the first experimental plantings made during the development stage, and it was thought then that such hills might be difficult to thin commercially. This later proved to be true in some cases.

The experimental hill plantings gave the following results: The seed saving amounted to from 60 to 65 per cent. Approximately 17 per cent of the thinning time was saved on sedimentary soil beets. On peat land in the Sacramento River delta, however, where germination conditions were ideal and the stand very good, the seedlings in each hill were thick and closely grouped, and it took 22 per cent longer to thin the hill-planted beets than comparable drill stands. The usual drill seeding rate on the peat is less than the customary 20 lb per acre of other soils, and the seeding rate for the hill planter probably should have been less.

An objectionable feature of the hill planting appeared in the experimental plantings, namely, the loss of entire hills during the thinning operation. Where the seedlings in the hills were very compactly grouped and especially on the loose peat soils where the growth was rapid and the roots quickly became interwoven, it was difficult to pull out all but one seedling. Often all seedlings in the hill came out together. Losses ranged from 13.6 per cent on sedimentary soils to 19.7 per cent on late thinned, peat land beets. In general it was found that the hills were slightly too compact. This difficulty can be remedied, however, and changes have been made in later machines to increase the seed scatter. More machines have been put out this season and an increased acreage has been hill planted.

Mechanical cross blocking was developed a few years ago and has been discussed previously. A description is given in USDA Leaflet 97, entitled "Cross Blocking Sugar Beets by Machine," published in 1933. This practice of blocking the beets mechanically, using an ordinary cultivator equipped with weeder knives spaced to leave the desired size blocks and working crosswise of the rows, is increasing in popularity. In many areas it is the accepted system. Because large acreages can be rapidly covered the timeliness of the operation is especially important to some growers, particularly in California where the demand for hand labor at blocking and thinning time is high.

A new development in mechanical blocking is its experimental use for mechanical thinning. Knives with a 2-in cut are set on 3-in centers, thus leaving four uniformly spaced, one-inch blocks per foot of row. A number of these one-inch blocks will contain single seedlings and others two or three. By using a long-handled hoe for thinning and leaving some doubles the labor of thinning is materially reduced and satisfactory stands were obtained.

A formula was developed, in connection with the cross blocking, for determining the theoretical after-thinning stand from the germination stand, the width of cut of the knives and the width of beet blocks left. Using this same formula for one-inch blocks left with 2-in blanks between and on a good stand of beets, there would be over two hundred beet-containing blocks per hundred feet of row. From previous ordinary cross-blocking work it was determined theoretically that around seventy of the one-inch blocks would contain single seedlings.

Counts made on a plot experimentally thinned showed that there were 209 beet-containing blocks left per 100 ft of row, and of these 65 contained singles. The average beet in the mechanically-thinned plot was smaller at harvest time than a comparable hand-thinned beet in an adjacent plot, but there were more marketable beets per 100 ft of row in the mechanical thinning. The yield of the machine-thinned beets was slightly higher.

The fall labor peak in producing sugar beets occurs at harvest time. More experimental work had been done to develop machinery to do this job mechanically than has been done on all other phases of mechanizing the crop. Experimental machines have been built for many years and numerous patents have been granted, yet we still do not have a sugar beet harvester in commercial production and in general use. However, it looks as though we may have a commercially acceptable machine before long.

Harvesters have been of two general types, those topping the beets in the ground and elevating the topped roots; and those elevating the beets, tops and all, and topping in the machine. Of the harvesters of the former type, which top in the ground, none has as yet been satisfactory, and not particularly because of unsatisfactory topping. Some of the machines have done a fairly satisfactory job of topping, using a floating topping knife, reciprocating, revolving, or stationary. Height of topping has been gauged by shoe, wheel, or track.

In general, the greatest difficulty with this type of harvester has been the separation of beets from clods, after the beets have been topped and elevated. Many devices for mechanical separation have been tried, such as shaking or bumped conveyors, piercing pickup wheels, and conveyors with a rubbing or rolling action. Hand separation has also been tried, but under cloddy conditions there were too many clods to be picked from the beets, and the beets came up too fast for a reasonable number of men to pick them from the clods.

There are at present several harvesters of the topping-in-the-machine type in various stages of development. One has progressed to the point where it seems to be very near the commercial stage. It was started several years ago from a commercial red beet harvester built by the same company. One of the earlier models was described by E. M. Mervine in a paper published in AGRICULTURAL ENGINEERING for May 1932.

Successive models have been built each year since. The harvester has evolved from a heavy, expensively constructed, self-propelled machine to one much lighter and less expensive. It is a trailer or pulled machine using a power take-off from the pulling tractor to drive elevating and topping mechanisms. It is now a 2,600-lb machine comparable in mechanical construction to a corn picker. It is a single-row machine which can readily be pulled by a tractor of 20 or 22-drawbar horsepower, even in hard, dry, heavy soil.

The machine has a pair of gathering points, similar to a corn binder, which straddle the row being harvested and lift the leaves. A pair of rubber-faced elevating chains grasps the beet tops, and at the same time a lifting plow running directly under the beet row loosens the roots. As the harvester travels forward, the elevating chains carry the beets back and upwards, thereby lifting them by the tops nearly vertically out of the ground. The beets are elevated to and grasped by a pair of roller bars. This unique mechanism works the beet top up between the moving bars until the crown is against the bottom of the bars which gauge it for topping. At the same time the roller bars move the beet back to the two revolving-disk topping knives. These disks have serrated edges and turn towards each other, in that way pulling the beet into the knives as it is topped. The disks are set at an angle which gives an inverted V or roof-like cut to the top of the beet.

The topped beets are dropped on to a cross conveyor elevator which carries them to a small hopper holding about 200 lb. They are thrown over a gap from the end of the elevator into this hopper to effect a separation from leaves and dirt. The operator on the machine dumps the beets in piles forming cross windrows.

The crowns and tops are carried back from the knives to a cross conveyor. This conveyor has an intermittent drive engaged by the operator to dump the tops in piles also forming cross windrows. The tops are thus saved for feed in better shape and with less loss than by much of the hand harvesting.

Two of these harvesters were built this past year. One was tested in three districts in California and in Colorado. The other was used in Ohio. In California the machine was tested on sedimentary soil, partial sediment, and peat soil, to determine its possibilities under the different conditions found there. Performance tests were made later in Colorado to determine the comparable quality of its work.

The harvester was found to do very creditable work where the beets were at all uniform in tops and in height above the ground. An occasional beet was missed because its crown stuck up above the ground, or because of a poor top, but in general the tops were satisfactory for the harvester. On the partially sedimentary soil, where some of the tops were poor because of a spring attack of mildew, the loss from beets missed in the field was less than 2 per cent. Counts made on a number of hand-harvested fields in California showed an average loss of 2½ per cent.

An occasional beet topped in the machine had to be hand trimmed by the operator, but the average topping job done by the harvester was comparable with the usual run of hand topping. In general the machine performed in a most encouraging manner and a number of growers and sugar company representatives who visited it in operation were very enthusiastic about it.

The following results were obtained during the performance tests made during the early part of the harvest season in Colorado:

	Hand harvested, per cent	Machine harvested, per cent
Dirt tare	7.86	4.68
Top tare	0.84	1.15
Total tare	8.70	5.83
Low topping loss	1.46	2.20
Beets missed tonnage	2.40*	0.38
Total loss	3.86	2.58
Weight saved due to "roof" of machine cut		2.10
Net loss	3.86	0.48
Beets missed number		1.02

*Average loss in several California fields.

Under some field conditions the harvester did not do as good work as the table shows. However, under average conditions or better the machine apparently does topping equally as good as or better than hand work.

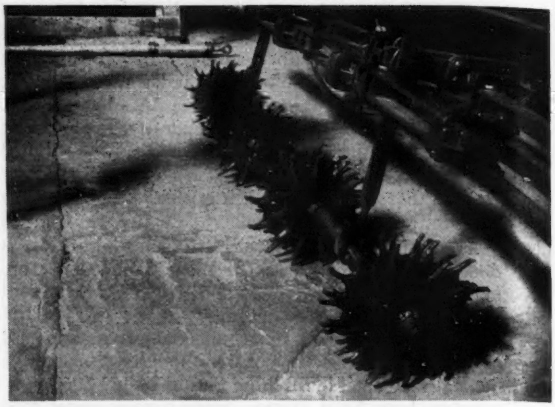
This harvester, as has been mentioned, dumps the beets from a hopper into piles forming cross windrows. There is no reason why the elevator to the hopper could not be extended and carry the beets directly into a truck. However, for experimental uses the small hopper is preferable and for commercial use in the eastern areas where individual acreages are smaller, the hopper seems quite satisfactory.

We understand that the company is building six machines for this season's harvest. Some minor changes are being made in the hitch and power-take-off and some points are being strengthened, but, in general, the machine will be similar to last year's harvesters.

Other problems than that of reduction of labor peaks have come up in the sugar beet machinery research. One that occurs more or less each year is that of soil-crust formation following rains at seed germination time, and the breaking of this crust. Many different kinds of equipment have been tried with varying degrees of success.

A crust breaker has recently been developed which has proved very effective in handling the situation. It consists of units made up of small, spiked wheels similar to rotary hoe wheels. The wheels are alternately 10 and 11 in in diameter, the larger wheels fitting loosely enough on the shaft so that all wheels touch the ground. This provides a self-cleaning feature. A set of these units covering each beet row is mounted on an ordinary beet cultivator. Repeated tests have proved these crust breakers to be very satisfactory.

Bed planting of sugar beets is a new practice creating a demand for some new equipment. It originated in California in 1930 and 1931 and is increasing in popularity in some of the irrigated districts. It consists of listing up ridges on 40-in centers, harrowing them down in the spring, and planting two rows of beets on the flat-topped beds which are approximately 6 in high. The practice originated in head lettuce growing and in general the lettuce planting equipment of sled bed planters, cultivators, etc., is used. This method of planting when applied to sugar beets presents a spring problem of clean-up of weedy, overwinter beds. Equipment is being developed to meet this situation of weed control as well as others arising from the application of the practice to sugar beets.



THE NEW CRUST-BREAKING UNITS MOUNTED ON AN ORDINARY BEET CULTIVATOR WERE VERY EFFECTIVE

Tractor Engine Lubrication under Low Temperature Conditions

(Continued from page 466)

diluted oils to reduce the resistance when cranking. In many engines the oil is drained out of the engine at the finish of the day and heated when put in in the morning. The heat from the oil is quickly absorbed by the crankcase of the engine so that the delay in warming up is reduced. The radiator is usually covered to facilitate rapid warming. The engine is also operated at a fairly high rate of speed in order that rapid warming may result. However, in spite of all the precautions, it is practically impossible to lubricate an engine during the long warming-up period. There is considerable blow-by past the pistons, which carries water vapor down into the cold crankcase, where it condenses. The water vapor mixes with the oil, forming an emulsion of water and oil, or a sludge. Oils tend to sludge with the addition of dirt, or by the oxidation of non-stable oils. There is very little sludge formation during the spring and summer operation, particularly where the oil is drained or strained regularly. There is, however, considerable water sludge formed during the colder periods of operation, which makes it practically impossible to lubricate an engine adequately.

The Standard Oil Development Company have conducted research on engine wear during the warming-up period for zero weather conditions with the following results:

1 Starting and warming up an engine at 0.0 deg F results in 13.2 times the wear which would have occurred had operating temperature been normal. (If the engine did not warm up during this 20-min period, the wear would have been 85 times normal wear).

2 Each start and warming up at 0.0 deg F is the equivalent of 130 mi, or an additional mileage, during the 20 min warming up at 30 mph, of 120 mi which do not show on the odometer life of the car.

When operating in zero or subzero weather, an engine which is worn or has been equipped with new rings which do not fit the cylinders, an excessive amount of water sludge is formed, to such an extent that the filters, oil pump, strainers, and crankcase may freeze up, preventing the correct functioning of the lubrication system. The crankcase then needs to be heated with a torch or the tractor brought into a heated building and thawed out. The sludge can be settled out and the oil poured off the top and used again. The only remedy for this condition is to overhaul the engine, with new pistons and cylinders fitting closely to prevent blow-by of the exhaust gas. The crankcase should be covered with an insulating material to protect it from severe cold. The radiator needs to be covered entirely until the cooling liquid is warmed up nearly to boiling. Light oil must be used to facilitate starting, and the engine kept hot while operating. It is desirable to keep the engine in a warm place to prevent it from becoming excessively cold, whenever possible. Oil should be used in the gasoline at all times.

In conclusion, the tractor engine must be given special consideration when operated in western Canada if adequate lubrication is to be had. The engine must be warmed up quickly and maintained at a reasonably high operating temperature. The oil must be clean and of a grade which will flow freely in forming a mist to lubricate the working parts of the engine. The use of top lubrication or oil in the gasoline to protect the piston rings and cylinders during the warming-up period is imperative. Finally, the engine must be in good mechanical condition and protected from the extreme cold when operated in zero or subzero weather.

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Present Status of Electric Fencing

By George W. Kable

IT CAN hardly be said of the electric fence that it is a load building device, at least not from the standpoint of the power which it consumes. Farmers who have used these fences have reported only slight increases in the monthly power bills. Actual measurements establish the electric fence as a power user of the order of 5 to 10 kwh per month. Some types of fencing units are not even connected to the power circuit but derive their electric "kick" from a few dry cells.

Most farm fences, whether they restrain the bellicose bull or the hungry hog with an electric punch, a pricking barb, or a maze of sturdy woven wire, are erected as an aid in carrying out a crop or livestock management program. Whether the fence is desirable or profitable will depend on what contribution it can make to the farm program and the farm income.

The electrified fence, as the name implies, carries a charge of electricity which is imparted as a shock to livestock coming in contact with it. A few shocks from such a fence wire apparently imbue an animal with a respect for stretched wire and a sense of measurement which enable it to walk up to the wire or graze beneath it without being so indiscreet as to come in contact with it.

The charged fence has made a strong appeal to farmers. Wherever it is mentioned or a fencing unit is displayed, there is immediate interest. Such interest may be prompted in part by curiosity, but it is a pretty good indication that fencing still presents problems to the farmer which have not been solved to his complete satisfaction.

As nearly as can be estimated, about 5,000 electric fencing units have been sold to farmers since 1932. Most of these units are in Wisconsin, where the idea was first introduced. Three companies are now selling fencing units.

In endeavoring to learn the facts your committee on electric problems has contacted many farmers to learn what they think of electric fencing. Most of the replies sound too much like cosmetic testimonials to present to a technical society. The farmers quite evidently were pleased, and there were no reports of injury to stock, humans or property resulting from the use of fences carrying charges from specially designed fence controllers.

From the New England section N. D. Herrick reports information from 25 users of commercial fencing units and two users of homemade installations. There were no citations of any harm done to persons or livestock.

An interesting survey was recently conducted by Hobart Beresford in Idaho.

Following are some of the comments of Idaho farmers:

1 "It makes a bull pen large enough to allow exercise, at low cost. It allows a loose-wire crooked fence to be built to follow ditches. Objection: Some radio interference, high initial cost."

2 "One wire around hay stack keeps stock out."

3 "Am hogging off 6-acre grain field—small pigs to large hogs—and have held them without trouble. For cattle and horses it is perfect."

4 "Eliminates danger of cuts on cows and horses. For temporary fence it can't be beat, and I got it for fencing in irrigation ditch."

5 "It is not necessary to repair the bull-pen fence every day since installing the electric fence."

6 "Put screens on corners of building for dogs; very successful."

7 "Have weaned mule colts from mares with two wires."

8 "From standpoint of security and peace of mind I consider the electric fence one of my best investments I have on my farm."

9 "This is the best remedy for breachy stock that I ever used."

Mr. Beresford comments further on the effect of electric fence "shocks" when the ground is wet. He says, "The more effectively an animal is grounded the more potent the shock becomes. Many irrigated pastures and ditch banks are fenced with electrified wire, and no injury to livestock has been reported."

Not all electric fences have a clean record of safety. T. E. Hienton of Indiana reported a horse killed where the fence was connected directly to a 110-volt circuit. He also reported a dog killed by a fence having a 7½-watt lamp in series with the fence wire. I. P. Blauser of Ohio reports three cows killed by a fence energized at 110 volts from a lighting circuit. Five cows were killed in Illinois with a 110-volt circuit, according to a report by F. C. Kingsley. D. C. Genther of Acampo, Calif., killed a 400-pound hog and almost killed a cow when the ground was wet. E. L. Gengler, of Brown Deer, Wis., killed a horse in the early days of his experimenting with electric fences. The death of a woman from touching the hot electrode of a 110-volt "fish worm extractor" is related. This was not a fencing unit, but it indicates the hazard of bare lighting-circuit connections in proximity to grounds.

Farmers have found many ways in which to use the electric fence to their advantage. Some of these merit recording.

The chief point of favor appears to be the low cost and ease with which temporary fences may be erected for pasture rotation, hogging down corn, pasturing ditch banks, and dividing fields. Others are training horses and cows to keep away from barbed wire, and thus prevent wire cuts; keeping hogs from rooting under wire fences; breaking hogs from killing chickens by fastening the shock wire to a dead chicken placed in the pen; keeping fence rows clean; lessening of erosion by avoiding ditches adjacent to permanent fences; stop fence jumping, crowding, and reaching over; elimination of weekly repair of the bull-pen fence.

Utility companies and safety bodies are at variance regarding electric fences. The Edison Electric Institute has issued a warning relative to the possible danger to life and the liability of utilities approving electric fences. On the other hand, Roy E. Hayman, of the Oklahoma Gas and Electric Company, states that electric fences are performing

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Author: Chief, rural electrification and farm machinery section, Agricultural Industries Division, Tennessee Valley Authority. Mem. ASAE.

satisfactorily, are helping Oklahoma stockmen, and that his company is advocating their use and is not afraid of the consequences. E. C. Kingsley, in a paper in AGRICULTURAL ENGINEERING for June 1936, reported that, in the territory of the Illinois Northern Utilities Company, electric fences were interesting the farmers and giving satisfactory performance.

S. A. Witzel, of the Wisconsin Agricultural Extension Service, who dodges about among several thousand electrified fences, reports considerable enthusiasm on the part of stockmen and of the Wisconsin Dairy Herd Improvement Association. While sympathizing with this interest, and telling farmers of the electric fence, he keeps his fingers crossed, and also presents the "Warning Regarding Electric Fences," issued by the industrial commission of the state. This admonition is representative of the attitude of a number of safety commissions. In addition to warning against the obviously dangerous practice of connecting fence wires directly to a lighting circuit, or to a lighting circuit through an incandescent lamp, the following statement is made: "It is still questionable whether it is possible to charge a fence in such a manner as to frighten livestock and still be entirely safe under all conditions. The commission points out, also, that none of these devices is actually guaranteed to be proof against breakdowns and other failures, or to be absolutely safe under all conditions."

Since the above warning was issued, it is reported that the commissioner of labor in Oregon has approved the sale in Oregon of 6-volt and 32-volt, direct-current controllers, and of 110-volt, alternating-current controllers of one prominent manufacturer.

Three types of fence controllers are available on the market. Two are similar and operate on 6-volt or 32-volt direct current. The third is used on 110-volt, alternating-current circuits.

Either storage or dry cell batteries may be used for energizing the 6-volt units. It is claimed that four 1½-volt dry cells will operate a fencing unit for two months, and that it will handle up to five miles of fence.

The direct-current controllers consist primarily of a small transformer or coil, which steps the voltage up to values from 350 to 30,000 volts, a circuit interrupter, and condensers. The current carried by the fence wire is very small. With 6-volt batteries the current is much below the accepted limit of danger to stock or humans.

The main parts of an alternating-current controller are a one-ampere limiting fuse, a series lamp in the fence circuit which limits the fence current to 20 to 80 milliamperes, a circuit interrupter to de-energize the line periodically, a pilot lamp to show whether the interrupter is working properly, and coils and condensers to reduce radio interference. One unit has two taps to the transformer and a double-throw switch to provide different fence voltages for wet and dry weather.

A high-voltage, low-current controller was patented a number of years ago by A. D. McNair. It makes use of a bell-ringing transformer and a Ford coil to step up the voltage. A synchronous, motor-driven clock is used for interrupting the current. The unit has been tried in the field but is not on the market.

Research work is now under way at the University of Wisconsin, under the direction of F. W. Duffee, in an effort to produce a safe, reliable fencing unit at low cost. It is the intent to leave the voltage high enough to make smooth wire feasible for fencing, and the current low enough to insure safety.

Objections to fencing units are largely centered on the alternating-current device. One power company fears results should there be a breakdown between primary and secondary wiring in a line transformer. Other objections have been raised to the maximum current values through the fence, to possible breakdowns in the controllers themselves, and to the possibility of meddling with the unit and changing its characteristics. Assuming it to be possible to put good workmanship and materials into a controller, and that there is some hazard in the use of any electric current, the critical factor seems to be the limiting of fence current.

In a recent article by Ferris, King, Spence, and Williams[1] of the College of Physicians and Surgeons of Columbia University, and the Bell Telephone Laboratories, the statement is made that "the physiological effects of electric shock are related to the magnitude of the current rather than to the voltage. * * * Heart action has been given almost exclusive consideration because it seems to set the limit of current to be guarded against if fatalities are to be avoided." Small currents stimulate the sensory nerves and produce a tingling sensation of warmth. Beyond this threshold of sensation a point will *(Continued on page 475)*

[1]"Effect of Electric Shock on the Heart," Electric Engineering, May 1936.

CHARGED WIRE CREATES NEW FARM AND STOCK MANAGEMENT OPPORTUNITIES

Progress in Farm Electrification

By J. C. Scott

EXPERIENCE has proved that the use of electricity by the farmer, for only a short period of time, causes him to consider it a necessity rather than a luxury. He soon alters his farming methods so that electricity plays a very important part in reducing the cost of production, at the same time helping him to produce a better product.

The experience of power companies in electrifying farms, over a period of thirty years, indicates that there are five major factors to be considered in the problem of successful rural electrification: (1) line construction; (2) maintaining a continuity of service which the farm can depend upon; (3) helping the farmer to use electricity to his economic advantage; (4) cost of electric service to farmers; and (5) financing farmstead wiring and the purchase of equipment.

Line construction is a minor problem provided enough current will be consumed on each mile of line to make the line self-sustaining. Under the rules of the department of public service of the state of Washington, if a group of farmers along a certain proposed line makes application for electricity, the power company immediately makes a preliminary survey of the line. This is necessary, not only to determine the cost of the line and the number of customers to be served, but also to get an estimate of the amount of electricity each customer will use.

For each dollar of expected annual revenue, the power company invests $3.50 toward the construction of the lines, excluding transformers. If the estimated annual revenue is not sufficient for the line to be constructed without deficit on this basis, the farmer can either make a prepayment of revenue sufficient to overcome the deficit over a period of fourteen years or he has the option of guaranteeing an annual revenue to the amount of one-fifth the cost of the line, including transformers, for a 5-year period.

The power company not only constructs the line, but owns it, pays taxes on it, takes responsibility for possible damage, and keeps the line in constant repair. These are important factors for the consideration of farmers who are planning to electrify their farms.

If lines are properly constructed, and in most states they must be constructed to meet the specifications of the various state regulatory departments which supervise these activities, the cost of repairs will be negligible for a few years, but sooner or later lines must be repaired.

If farmers are to use a sufficient amount of electricity to make it economically possible to construct lines, it is necessary to maintain a continuity of service to the highest degree humanly possible. The farmer's wife will not use electricity for cooking, if she gets up a few mornings, turns on the switch, and finds no heat. If she invites a number of guests for Christmas dinner, and the electric current goes off at ten o'clock in the morning, making it necessary for the men to bring in the old cook stove from the shed and set it up in time to cook dinner, the atmosphere of the farm home is such that the electric range will not be depended upon. This unfortunate incident will be advertised among the neighbors to such an extent that others will be extremely skeptical with regard to the practicability of cooking with electricity.

The poultryman who is hatching and brooding chicks with electricity, must feel that his service is so continuous that electricity is safer than any other method. The experience of one farmer who was in the business of hatching and selling chicks is here related:

"I had two 16,000-egg electric incubators going. A bad storm came up, and at 1:00 o'clock in the morning the line in front of my place broke down. I thought a good part of my season's business would be ruined. However, I called the power company. A service crew came out, and although it was raining, and blowing hard, they climbed the poles and made the connections, repairing the wires while they were 'hot.' That is, they did not go to the trouble of cutting the current off on this line, since there were other poultrymen depending upon the service for brooding and incubating. By 2:00 o'clock the line was repaired and no damage was suffered. While watching those fellows repair that line in the rain that night, I told them they were taking their lives in their hands, in a manner I would not do for myself nor anyone else. They said it was all in the day's work, and as soon as the job was completed they hurried on to repair other service interruptions."

However, it is not always possible to repair lines quickly. Extremely heavy windstorms, silver thaws, etc., sometimes put the lines in large territories out of commission to such an extent that it requires time to repair them. Such unavoidable difficulties are placed in the same category with floods and fires, and nearly all farmers are tolerant towards the power company under such circumstances, as long as they have assurance that the management of rural lines is immediately doing all in its power, and that it has a capable and efficient organization to repair damages at the earliest possible moment.

Silver thaws in particular are a cause of destruction to rural lines and a source of great annoyance to farmers in some districts. In the winter of 1934-35, the damage resulting from a silver thaw cost one company in Washington considerably over $50,000 in one county alone.

It must be remembered that successful rural electrification depends upon the management of rural lines having set aside sufficient money to immediately start repair and reconstruction of lines put out of commission for any reason.

When a farm line is constructed, the power company sees to it that each farmer has sufficient transformer capacity so that his voltage will be high enough to operate all lighting and appliances. However, as the electric apparatus is increased on the farm, it is necessary to keep constant check on the voltage and occasionally to change the transformers and wiring in order that this apparatus can be operated satisfactorily.

While our farm electrification men continually give service by advising on wiring problems, the wiring from the meter to the apparatus is done by the farmer or by someone whom he hires to do this work.

If farmers are expected to use enough electricity to make general farm electrification possible, it is the business of the power company to be ever on the job attending to this type of service.

Farm electrification does not stop with the construction

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Author: Agricultural engineer, Puget Sound Power and Light Company. Mem. ASAE.

of the line and the farmer's use of lights and a few appliances. There should be no recess in our efforts until every sound and economical use of electricity is in operation on a farm, and when this is accomplished it is our aim to go farther and find still more ways in which the farmer can use electricity to his advantage.

Many farmers have electric service today who could not have had it a few years ago because much of the current-consuming apparatus now in use on their farms was not then in existence. Likewise, many farms cannot be served today, which, in years to come, it may be possible to serve because of the development of apparatus and machines which will help the farmer in his business and will make it profitable for him to use enough electricity to make the lines self-supporting.

When the first lines were constructed to serve farms, lights and a few other devices were the only use to which the farmer could profitably put electric current. After using electricity for lights it was realized soon that electricity should be used for many other farm operations, such as incubating and brooding chicks, warming water for chickens and livestock, dairy water heating for washing and sterilizing utensils, heating hotbeds, and the application of electric motors to farm machines.

These developments made it possible for other farmers, in farther outlying districts, to use enough electricity advantageously so that electric lines would be self-supporting.

Although a certain amount of this type of development work has been accomplished, there is much more to be done, much which can and should be done. The question is, "Who will do it?"

Experiment stations, power companies, and manufacturers are doing some valuable work in improving electric apparatus for use on the farm after the original idea has been conceived, but most of the original ideas come from farmers.

Farmers themselves can take a leading part in further farm electrification activities. What is needed is imagination, understanding, and judgment with regard to new uses of electricity that will help farmers do their work more economically and at the same time improve the quality of their produce.

EXTENSION WORK NECESSARY IN ELECTRIFICATION AS IN OTHER FIELDS OF FARM PROGRESS

After an apparatus has been developed, the farm electrification program with regard to this device has only begun. It must be manufactured and distributed, making it easy for interested farmers to obtain the equipment. Educational work is necessary to acquaint farmers with new electric methods and their advantages. These activities include farm demonstrations, descriptive articles in farm papers, radio programs, and talks at farmers' gatherings.

To suppose that a large amount of electricity will be used on rural lines without further effort on the part of power companies, manufacturers, educational institutions, and others, is a mistake. Most farmers are no different than anyone else. They buy merchandise which is brought to their attention through educational activities, advertisements, and other promotional work.

From the experience of power companies it is apparent that when they take a recess in the promotion and advertising of electric equipment of any kind, it is immediately reflected in a decrease of current consumption. Similarly, when promotional activities are pushed more vigorously, current consumption is increased.

The use of sufficient electricity on farms to justify construction of lines also depends to a great extent upon the ability of farmers to use electricity to their economic advantage. This is a personal problem of farm management.

There are poultrymen, for instance, brooding 30,000 chicks or more with electric brooders; developing husky, healthy chicks that grow into profitable laying pullets, with less than 5 per cent mortality, on from 1/3 to 1/2 kwh per chick for the brooding season. There are other poultrymen who find it extremely difficult to brood even 1,000 chicks without a loss of 10 per cent or more, and a current consumption of over 1.0 kwh per chick, and producing flocks of pullets which do not pay for their keep.

If a man cannot use electricity in a way that will make it possible for him to do his work more economically and get better results than by other methods, he should not use it. Some dairymen and poultrymen pay over $500 a year for electric current, some irrigationists pay as high as $2500 a year for electric service, finding it profitable to do so, but, before using such a large amount of electricity, it was necessary for these farmers to become convinced that the addition of electric apparatus to their farm operations could be economically justified.

Electric apparatus generally is not purchased from shelves in stores in the same manner as are overalls, sugar, and pitchforks. A tremendous amount of educational and service work must accompany the introduction of new farm electric apparatus in each community in order that the reputation of the electric method may be established.

FACTORS IN THE TOTAL COST OF ELECTRIC SERVICE

The service, assistance, and promotional work necessary in a program of farm electrification is all a part of the cost of electricity. The generation of electricity is a small part of the cost of electric current delivered to the farm.

The cost of electricity includes (1) generating current; (2) transmission of current from generators to centers of distribution; (3) distribution system, which includes construction and never-ending service of substations, transformers, and pole lines; (4) auditing and accounting, which includes meter reading, billing and collecting; (5) administration; (6) taxes; (7) interest; (8) depreciation; and (9) last, but not least in importance, the development of apparatus, and educational and promotional service, which includes the work of assisting farmers to use electricity to their economic advantage.

In arriving at a rate to be charged for electricity, maintenance of lines and other equipment should be calculated over a long period of years. A low rate may take care of maintenance for six to eight years, especially if there happens to be no serious damage caused by extreme weather conditions or other disaster beyond the control of the management. However, the only safe policy is to calculate rates on a basis of future replacement and possible disaster.

Rates do not indicate always the total cost the farmer pays for electricity. In some instances they do, but in other instances there are many additional costs which do not become evident until some time after the line has been in operation. Among these items are the cost of repairing worn and occasionally damaged generating systems and pole lines, damage of down lines to persons, property and livestock, and nonpayment of taxes by tax-exempt power organizations.

How does nonpayment of taxes affect the cost of electricity? The taxes levied against power companies are included in the rates charged for electricity. Taxes paid by the electric industry in the United States averaged 14.1 cents on each dollar of gross revenue in 1934, according to Statistical Bulletin No. 2, issued by Edison Electric Institute. These tax payments help all farmers in counties where

power companies operate. Tax payments constitute material contributions toward the support and maintenance of schools, provide for law enforcement, and contribute to the general fund for construction of roads.

If the organization delivering power service to a community does not bear its proportionate share of the cost of government, it must be made up by increased taxes levied against farmers and other business interests.

Taxes are a part of the cost of electricity just as they are part of the cost of bread, meat, clothing, and machinery.

However, neither the cost of electricity nor line construction costs are really the major problems in connection with a more widespread use of electricity on the farm.

Many farmers who have electric service, as well as many who do not have it, are convinced that a further use of current is exactly what they need, and yet they cannot use it on the farm because of the cost of appliances.

Recently D. B. Leonard, agricultural representative of the Pacific Power & Light Company in the state of Washington, in an effort to definitely establish the relationship between the investment in utilization devices and the annual kilowatt-hour consumption, made a very detailed survey and study of 100 farms. These farms were selected over a wide area in Oregon and Washington. Information was secured and charted by shotgun curve methods, to show equipment costs and power used. The farms selected were of all types, fruit, hay and grain, potatoes and truck, dairy and poultry. Typical customers were selected in each group, including some of the best users, some of the poorest users, and a number representing average users.

Wiring costs, including lighting fixtures, averaged $134.00 on each farm. These data show that the farmer using a small number of current-consuming devices, enough to consume 2,000 kwh annually, would be required to have an investment of $800 in equipment alone. The electricity would cost him about $50 a year, but the equipment to use the power would cost 16 times that amount.

For the farmer who uses 20,000 kwh of current annually, the cost of equipment would be $1600. When we add wiring costs to the cost of appliances, the amount which the modest farm homeowner would have to spend in preparing to use electricity would be about 20 times the annual current bill.

Many farmers would not hesitate to spend $5 a month for electricity to operate electric devices, but very few of them at this time are able to obtain $1000 to buy equipment with which to use the electricity. This is especially true of farmers heavily mortgaged or those whose taxes have not been paid during the past few years.

To solve the problem of helping farmers obtain electric home equipment, manufacturers, dealers, and power companies have inaugurated a system of low down payments and low monthly payments. The same effort should be made to assist farmers in the purchase of electric equipment to be used outside the home.

The financing of electric apparatus that will help the farmer in his business, help him produce more economically, needs more consideration than it is generally given.

Financing the construction of lines, and the rates paid for electricity, are not the big problems in some territories. As a matter of fact, electricity could be obtained easily by many farmers in the Pacific Northwest who do not have it, if someone could solve the problems of financing equipment and wiring.

So, while the electrification of farms in the United States should be initiated vigorously, yet it may proceed more slowly than we should like to have it. Like all good things of real value, general farm electrification in the United States probably will move to completion gradually.

Present Status of Electric Fencing

(Continued from page 472)

be reached at which an animal becomes unable to control the stimulated muscles and may "freeze" to the conductor. Experiments have indicated this limit of safe current to be about 15 milliamperes at 50 cycles.

It is to relieve this lack of muscular control that fencing units are designed to provide alternate periods with and without current flowing through the fence.

Death from electric shock is most likely to be caused by ventricular fibrillation, which is a change from the regular beating of the heart to a quivering action, in which the pumping of the heart ceases. The threshold values of current to produce this condition, determined experimentally, are given in the following table from the article cited:

Animal	Current, amperes		
	Minimum fibrillating		Maximum nonfibrillating
	Average	Range	Average
Dog	0.11	0.07—0.22	0.092
Pig	0.24	0.17—0.27	0.20
Sheep	0.25	0.16—0.39	0.24
Calf	0.31	0.21—0.47	0.27

Quoting further, "The value of current just under the threshold for ventricular fibrillation may be taken as the maximum current to which man may be safely subjected." Based on differences in heart and body weights, and on species, the limiting current for man is estimated at 100 milliamperes. The lower figures in the ranges above would apply to the respective lower types of animals.

From the Purdue University Agricultural Experiment Station we get the statement that "tests on swine conducted here * * * show that 25 to 30 milliamperes of alternating current are enough to cause contraction of their muscles, while 60 milliamperes will render them unconscious."

We, as engineers, now have reasonably definite data and factors upon which fence-controller design should be based.

First is the interest of farmers in a reliable fencing unit as a means of aiding a farm management program, or perhaps in bringing about a change in cropping or soil management which has been considered impractical in the past. In turn we might then list (1) the need of a device which will limit the maximum current on the fence wire to a safe value, possibly 10 milliamperes, voltage being relatively unimportant; (2) a reliable controller which is fool proof, not likely to break down internally, and which will keep extraneous high currents off the fence; (3) a controller priced low enough to sidestep the willingness of farmers to risk the hazard of an improvised system.

Should designers fail with alternating current, there is still the safe possibility of using 6-volt storage battery units with equipment for recharging the cells on the farm.

It is unlikely that the electric fence will replace all other types of fencing. We are interested in all types. Each will find its place in the economic program of the farm. And while the adjustment is going on, the engineer might well be winnowing out the sales propaganda and "new toy" enthusiasm from the sound economics of electric fencing by some comparative field studies of actual construction costs, uses, and advantages of different types of fences needed on the farm.

Specifications for Rammed-Earth Construction

By R. L. Patty

AN EXPERIMENTAL study for finding the resistance of typical South Dakota soils to weathering and for determining the relationship between soil characteristics and its resistance to weathering, has been carried on in the department of agricultural engineering, South Dakota State College, for nearly six years. The Bouyoucos hydrometer method of soil analysis was used in the study.

A very definite relationship between the soil characteristics and the resistance to weathering of a rammed-earth or pise' de terre wall made from this soil, has been found. The "total soil colloids," sometimes referred to by soil analysts as total "clay colloids," are of particular importance. As the total colloids increase in natural soil specimens, the weathering quality of the soil decreases.

While the study of weather resistance by the earth walls was made on unprotected surfaces in all cases, it has been found that soils with poor weather resistance as a bare wall are also more or less unfavorable for earth walls when protective coverings are used. There are rather definite limits in total colloidal content of soils, therefore, for a soil that is to be used in an earth wall without any protective covering whatsoever, and for a soil that is to be used in an earth wall with a protective covering. There is another definite limit to a soil that can be used in an earth wall under any condition.

Soils containing 30 per cent or less total colloids are especially good for rammed-earth construction. In all cases they have been found high in sand and low in clay. The four natural soils used in this experiment which fall within this class indicate that they might stand satisfactorily for many decades without any protective covering.

Natural soils containing more than 40 per cent total colloids are definitely poor for earth walls. They are not only unfit for bare walls but are also unsatisfactory for walls with protective coverings. Some of these soils may be made satisfactory by the addition of sand, thereby reducing the total soil colloids to within the maximum limit, but generally this is not the case. In all cases these walls must be covered.

A very definite relationship has also been found between the total clay or conventional clay in a natural soil and its resistance to weathering. Favorable soils will not contain much over 30 per cent of conventional clay and a soil containing 40 per cent or more is unfit for use. In one case only in this experiment has a soil exceeding 40 per cent clay been made fit for use by the addition of sand. Such a soil, even with a sand admixture to correct its texture, should not be used in practical construction until after a three-year weather exposure test.

Sand and mineral aggregates of all graduated sizes up to 1½ in in diameter improve all natural soils, except those containing 75 per cent or more of sand. No advantage has been found in any particular size of sand or mineral particles, so far as weather resistance is concerned. Bank run aggregate up to 1½ in and a plaster sand are equally satisfactory. A quicksand is the only aggregate that has proven unsatisfactory.

Experience in leaving unfinished wall sections standing through the summer season prove that a short wall section as thin as 12 in will warp under the action of the drying sun. In practical construction short wall sections may be disconnected from the continuous wall by door openings. The warping took place on north-and-south walls. This experience leads us to the conclusion that wall sections more than 6 ft in height and 12 in or less in thickness should in no case be left more than two weeks during the construction period in drying weather. Damp and cloudy weather will not cause warping.

For several reasons it would seem undesirable to build walls of pise' less than 12 in in thickness. The possibility of warping difficulties would be most important perhaps, and inasmuch as 12-in and 14-in walls are better insulators, more stable, and little more trouble to build, the thin wall is not justified. It is specified that walls of more than 8 ft in height, as used in farm building construction, be not less than 14 in thick. This thickness of 14 in should maintain for a wall from a height of 8 to 11 ft. Walls more than 11 ft high should be 16 in thick at the base.

Pise' walls should be built on good monolithic concrete foundations, the top 6 in of which should be the full thickness of the wall. The foundations for farm building walls should have footings 8 in wider than the thickness of the wall in average load-bearing soil, and should extend 12 in or more above grade.

Anchor bolts for bolting wood plates to the tops of rammed earth walls should have a length equal to the thickness of the wall plus the projection above the top of the earth wall. The metal anchor plate embedded in the wall with this bolt should be ¼ in thick and one square inch in area for each inch in thickness of the wall.

A thin coat of cement mortar should be used over the entire top of an earth wall before installing the plate.

These specifications may be briefed as follows:

1 *Soil Texture.* Soil must not contain more than 40 per cent and preferably less than 30 per cent conventional clay, of which not more than 40 per cent may be colloidal material. Above 30 per cent total soil colloids is allowable, only when the wall is to be given a protective covering of satisfactory material. Corrections may sometimes be satisfactorily made on soils exceeding these limits by adding sand or mineral aggregate up to not less than 70 per cent of the total soil by weight. Such admixture will improve a favorably textured soil in its resistance to weathering, and in no case will it injure a favorable soil.

2 *Warping.* An unfinished wall section of rammed earth with a height of 6 ft or more, and a thickness of 12 in or less, should not be left standing for more than two weeks at a time in drying weather without a protective coating to prevent warping.

3 *Foundation.* Pise' walls should be built on good monolithic concrete foundations of ample section (as defined above).

4 *Plate.* The wood plate should be bedded in a thin cement-mortar capping extending over the entire width of the pise' wall, and should be fastened with bolts and anchor plates of ample size (as defined above).

5 *Wall Thickness-Slenderness Ratio.* Minimum practical thickness of any pise' wall is 12 in. Maximum height for 12-in thickness is 8 ft. Maximum height for 14-in thickness is 11 ft.

A contribution of the ASAE Committee on Natural Building Materials.

Author: Professor and head of the department of agricultural engineering, South Dakota State College. Mem. ASAE.

Experimental Design of Vertical Drop Culverts

By H. B. Roe

(Continued from AGRICULTURAL ENGINEERING for October, 1936.)

METHOD OF PROCEDURE IN DETERMINING LOST HEAD

1 *Adjusting Q to any Desired Values.* Q was adjusted to the approximate value desired for any given series of tests by means of the weir hook gage, a sufficient time being allowed to elapse for equilibrium to be attained before the final reading of this gage was taken and the adjustment and reading of the experimental gages attempted. The weir hook was read and recorded several times, as a rule, during each setting for a given value of H.

2 *Actual Measurement of Lost Head, h.* H was adjusted approximately to any desired value by means of the gates in the main flume head wall, the actual elevation of tailwater being determined by flume hook gage and that of the headwater by point gage. With Q established, time was allowed also for the total lost head, h, (the difference between the elevations of headwater and of tailwater), to attain equilibrium. This condition of equilibrium was determined by frequent simultaneous readings of hook and point gages, and, when it appeared to be nearly established, a series of readings of hook and point gages was taken at intervals of approximately 3 to 5 min until a successive series of such readings (usually five) was secured in which h was either stable or showed a marked variation between successive readings as a rule not in excess of 0.001 ft. It was further endeavored to secure these five readings in a group where, if h were not absolutely stable, the fluctuation between successive readings was alternately up and down rather than continuously all in one direction. These five readings for any given setting were then recorded and the average of the value of total lost head computed from them was the value used in plotting the relationship between h and H (see Tables 1 to 3 and Figs. 5 to 7) as the points in any series of five readings so chosen are too close to plot all the points without interference and blurring.

3 *Uncontrolled Variations in Q.* As directly plotted results, especially for low values of Q, in some cases, showed an unreasonable scatter, it was concluded that the fluctuations of head on the weir within the limits of possible minimum readings on the weir hook were sufficient seriously to affect the apparent results. The smallest possible reading on the weir hook was 0.0005 ft. Observation showed that there

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TABLE 1. DETERMINATION OF TOTAL LOST HEAD

Medium tube (0.2029 ft in diameter); high Q; no plate; all dimensions in feet

$K = 2.3600$ $h_1 = 1.1735$
Standard $Q = 0.2034$ cfs

Q, in cfs	G_h on tail-water	G_p On lip of tube	G_p On head-water	H	Total Lost Head, h: Observed	Reduced to standard Q	Computed by formula*	Variation of observed from computed h: Per cent
0.2034	2.9780	0.1347	1.7900	1.6533	1.1720		1.1717	+0.03
0.2034	2.7850	0.1346	1.5960	1.4614	1.1710		1.1721	—0.09
0.2034	2.5315	0.1345	1.3460	1.2115	1.1745	same	1.1728	+0.15
0.2034	2.2820	0.1342	1.0970	0.9628	1.1750		1.1736	+0.12
0.2034	1.8895	0.1335	0.7050	0.5715	1.1755		1.1755	0.00
0.2034	1.5785	0.1328	0.3970	0.2642	1.1785		1.1784	+0.01

*The logarithmic formula is Log h = log 1.1735 — 0.0031 Log H.

(NOTE: During the running of the series of data shown in Tables 1 and 3, for some reason not evident, the flow and the whole behavior of the apparatus was steadier than during any other periods of the laboratory work. In these series almost perfect equilibrium was secured promptly, and maintained as long as desired, so that in each run there was no change in the gage readings. This explains why, Tables 1 and 3, only one set of readings is recorded for each run instead of five and an average as given in the other tables.)

TABLE 2. DETERMINATION OF TOTAL LOST HEAD

Medium tube (0.2029 ft in diameter); medium Q; no plate; all dimensions in feet

$K = 2.3800$ $h_1 = 0.6430$
Standard $Q = 0.1503$ cfs

Q, in cfs	G_h on tail-water	G_p On lip of tube	G_p On head-water	H	Total Lost Head, h: Observed	Reduced to standard Q	Computed by formula[a]	Variation of observed from computed h: Per cent
0.1472	3.4550	0.1274	1.6995	1.5721	0.6245			
	3.4540		1.6960	1.5686	0.6220			
	3.4525		1.6950	1.5676	0.6225			
	3.4515		1.6930	1.5656	0.6215			
0.1472	3.4500	0.1274	1.6915	1.5641	0.6215			
		Average		1.5675	0.6224	0.6485	0.6421	+1.00
0.1472	3.2075	0.1274	1.4405	1.3131	0.6130			
	3.2060		1.4395	1.3121	0.6135			
	3.2035		1.4375	1.3101	0.6140			
	3.2000		1.4360	1.3086	0.6160			
0.1472	3.2015	0.1274	1.4335	1.3061	0.6120			
		Average		1.3100	0.6137	0.6400	0.6425	—0.39
0.1503	3.1750	0.1274	1.4345	1.3071	0.6395	0.6395		
0.1501	3.1740		1.4310	1.3036	0.6370	0.6387		
0.1501	3.1735		1.4290	1.3016	0.6355	0.6372		
0.1501	3.1735		1.4275	1.3001	0.6340	0.6340		
0.1503	3.1745	0.1274	1.4280	1.3006	0.6340	0.6340		
		Average		1.3025		0.6365	0.6425	+0.94
0.1472	2.8900	0.1274	1.1255	0.9981	0.6155			
	2.8910		1.1275	1.0001	0.6165			
	2.8920		1.1290	1.0016	0.6170			
	2.8950		1.1310	1.0036	0.6160			
0.1472	2.8965	0.1274	1.1325	1.0051	0.6160			
		Average		1.0015	0.6162	0.6425	0.6430	—0.08
0.1503	2.8585	0.1274	1.1240	0.9996	0.6555			
	2.8485		1.1130	0.9856	0.6445			
	2.8455		1.1040	0.9766	0.6385	same		
	2.8440		1.1020	0.9746	0.6380			
0.1503	2.8410	0.1274	1.0995	0.9721	0.6385			
		Average		0.9810		0.6430	0.6430	0.00
0.1503	2.4830	0.1274	0.7450	0.6176	0.6420	0.6420		
	2.4835		0.7440	0.6166	0.6405	0.6405		
0.1503	2.4840		0.7440	0.6166	0.6400	0.6400		
0.1501	2.4845		0.7445	0.6171	0.6400	0.6417		
0.1500	2.4850	0.1274	0.7450	0.6176	0.6400	0.6426		
		Average		0.6170		0.6415	0.6440	—0.3[illegible]
0.1500	2.0650	0.1274	0.3380	0.2106	0.6530	0.6556		
0.1500	2.0650		0.3400	0.2126	0.6550	0.6576		
0.1498	2.0700		0.3440	0.2166	0.6540	0.65[illegible]4		
0.1498	2.0735		0.3460	0.2186	0.6525	0.656[illegible]		
0.1500	2.0770	0.1274	0.3480	0.2206	0.6510	0.65[illegible]6		
		Average		0.2158		0.6565[b]	0.6461	+1.61

[a]The logarithmic formula is Log h = log 0.6430 — 0.0031 log H.
[b]Float again greatly increases lost head when low over mouth of tube.

could be fluctuations of head on the weir hook either way, up or down, of very nearly this amount before either the skin of the water lifted away from the point of the gage in rising, or before it was pierced by the point in dropping. If it be assumed that lost head (h) varies as the square of the discharge (Q)—and this is very nearly true—it will be seen that the condition just described will give possible maximum variations in h, with variations of 0.0005 ft either way from the true reading of the weir hook, from the assumption of absolute equilibrium, very nearly as follows for the four largest standard Q classes used.

Q Class	Per cent variation
0.6005 cfs	1.0 (approximately)
0.4110 cfs	1.0 (approximately)
0.2034 cfs	1.4 (approximately)
0.1503 cfs	1.5 (approximately)

The percentages of possible error just recorded would be divided approximately in half for any given reading of weir hook, according as the exact head were over or under the accepted reading of the weir hook. As the resulting possible error for any reading for the four larger Q classes was not, therefore, greatly in excess of the agreed upon maximum limit of error of 0.5 per cent in these tests, the weir hook readings, made frequently and with care, and checked occasionally by weighings in doubtful cases, were accepted as giving usable values of Q in the four larger Q classes.

However, the possible error for any of the smaller Q classes (0.1060, 0.0825, or 0.0648 cfs) would increase rapidly as the value of Q decreased. Therefore, it was considered that, for classes of Q below 0.1503 cfs, determination by weir hook would be undesirable. Hence, for such Q classes, the value of Q was determined, in every case, only by weighings taken during 5 or 10-min intervals in the period during which the measurement of h was taking place. No set of values of h was finally accepted until the series of weighings of Q showed a maximum variation not in excess of 0.5 per cent.

METHODS OF COMPUTATION

1 *Computation of Head, H, on Lip of Tube.* For any set of readings of hook and point gages the head on lip equals the point gage reading on the headwater diminished by the point gage reading on the lip of the tube, or

$$H = G_p - G'_p \qquad [1]$$

For example, in Table 2 (data for the medium tube, medium Q, no plate) item 19 counting from the top of the table, $G_p = 1.1255$ and $G'_p = 0.1274$; hence

$$H = 1.1255 - 0.1274 = 0.9981$$

Such a value of H is spoken of elsewhere in this discussion as "observed H."

2 *Computation of Total Lost Head, h.* For any set of readings of flume hook gage and point gage, the lost head, h, equals the point gage reading, G_p, on the headwater plus the calibration constant, K, between hook gage and point gage diminished by the corresponding hook gage reading G_h, on the tailwater, or

$$h = G_p + K - G_h \qquad [2]$$

For example, referring to the same set of readings (Table 2, item 19), G_p is 1.1255, K is 2.3800, and G_h is 2.8900; hence

$$h = 1.1255 + 2.3800 - 2.8900 = 0.6155$$

Such a value of h is spoken of henceforth in this discussion as "observed h."

TABLE 3. DETERMINATION OF TOTAL LOST HEAD

Medium tube (0.2029 ft in diameter); low Q; no plate; all dimensions in feet

$K = 2.3600$ $h_1 = 0.1960$
Standard $Q = 0.0825$ cfs

Q, in cfs	G_h on tail-water	G_p On lip of tube	G_p On head-water	H	Total Lost Head, h: Ob-served	Total Lost Head, h: Reduced to standard Q	Total Lost Head, h: Com-puted by formula[a]	Variation of observed from computed h: Per cent
0.0807	4.0105	0.1367	1.8370	1.7003	0.1865	0.1949	0.1957	—0.41
0 0807	3.6455	0.1367	1.4730	1.3363	0.1875	0.1960	0.1958	+0.10
0.0807	3.2090	0.1362	1.0375	0.9013	0.1885	0.1970	0.1961	+0.46
0.0807	2.8160	0.1356	0.6435	0.5079	0.1875	0.1960	0.1964	—0.20
0.0807	2.7990	0.1356	0.6280	0.4924	0.1890	0.1975	0.1964	+0.56
0 0807	2.6230	0.1346	0.4520	0.3174	0.1890	0.1975	0.1967	+0.41
0.0807	2.5440	0.1345	0.3710	0.2365	0.1870	0.1954	0.1969	—0.76
0.0807	2.4185	0.1340	0.2590	0.1250	0.2005	0.2095	0.1973[b]	+6.18

[a]The logarithmic formula is Log $h = \log 0.1960 - 0.0031 \log H$.

[b]Here again the float, when down close to the tube, greatly increases the lost head, the only pronounced case of the kind where Q is very small. (See "Note" below Table 1.)

3 *Reduction of "Observed h" to the Value of h Corresponding to the Given Q Class.* For constant values of H and d, it is assumed for the present purpose that h varies as Q^2. This is very nearly true in any case and exactly true, for all practical purposes, to four decimal places, for the small variations in Q that occur in these tests, or,

$$h/h' = Q^2/Q'^2$$

$$\text{Then } h = h'(Q^2/Q'^2) \qquad [3]$$

For example, referring to the same set of data as under 1 and 2 just above, Q in this set has been determined as 0.1472 cfs. This item belongs in the 0.1503 cfs Q class, hence the observed h will be too small; but h' is 0.6155, Q is 0.1472, and Q' is 0.1503; therefore

$$h = 0.6155\ (0.1503/0.1472)^2 = 0.6417$$

DEVELOPING THE FORMULA

1 *The Relation Between h and H.* Eighteen tables, the final results in which were worked out in the manner just shown, contained the values of H and h from which the graphs in Figs. 5, 6, and 7 were plotted. Owing to lack of space only Tables 1, 2, and 3 are shown, but these are typical in form and content of the entire eighteen. The mathematical relation between H and h determined from the graphs in each of the nine cases without plate are summarized in Table 4. In all cases this relation takes the general form $h = h_1 \cdot H^{-0.0031}$. That is, h is a function of $H^{-0.0031}$, or $h = f(H^{-0.0031})$,

$$\text{or} \quad \log h = \log h_1 - 0.0031 \log H \qquad [4]$$

2 *General Relationships in Terms of Dimensionless Numbers.* Although the experimental measurements of linear values were all made in feet, it will be better, in the final analysis, to express all values in general terms in order to make final results independent of the systems of measure used, that is, to express all relationships in terms of dimen-

TABLE 4. SUMMARY OF RELATIONS BETWEEN h AND H

Diameter of tube, ft	Q Class	Q cfs	Algebraic formula	Corresponding logarithmic formula
			NO PLATE	
0.3046	High	0.6005	$h = 2.0240H^{-0.0031}$	$\log h = \log 2.0240 - 0.0031 \log H$
	Medium	0.4110	$h = 0.9390H^{-0.0031}$	$\log h = \log 0.9390 - 0.0031 \log H$
	Low	0.2034	$h = 0.2315H^{-0.0031}$	$\log h = \log 0.2315 - 0.0031 \log H$
0.2029	High	0.2034	$h = 1.1735H^{-0.0031}$	$\log h = \log 1.1735 - 0.0031 \log H$
	Medium	0.1503	$h = 0.6430H^{-0.0031}$	$\log h = \log 0.6430 - 0.0031 \log H$
	Low	0.0825	$h = 0.1960H^{-0.0031}$	$\log h = \log 0.1960 - 0.0031 \log H$
0.1393	High	0.1060	$h = 1.4605H^{-0.0031}$	$\log h = \log 1.4605 - 0.0031 \log H$
	Medium	0.0825	$h = 0.8910H^{-0.0031}$	$\log h = \log 0.8910 - 0.0031 \log H$
	Low	0.0648	$h = 0.5450H^{-0.0031}$	$\log h = \log 0.5450 - 0.0031 \log H$

sionless numbers. In the case of the relationships already established between h and H, this may be done by transforming the nine equations in Table 4 to read in terms of h/d and H/d, both of which are pure numbers since h, H, and d are all linear values in the system of measure where the foot is the unit.

This transformation is accomplished by solving each of the original nine formulas in turn for the value of h when H equals d for each particular case of different diameter and different Q class, and then dividing each of these computed values of h by the corresponding value of d in feet. Successive results are values of h_1/d for each corresponding new equation in turn. These nine equations will then read as shown in Table 5, and they will all take the general form

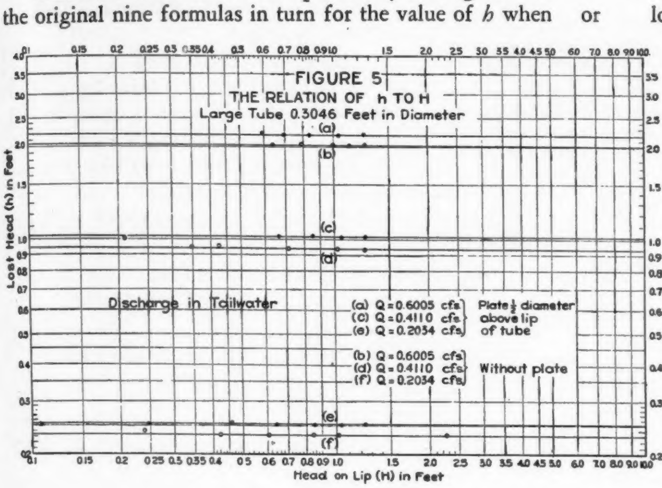
$$h/d = (h_1/d)\ (H/d)^{-0.0031} \qquad [5]$$

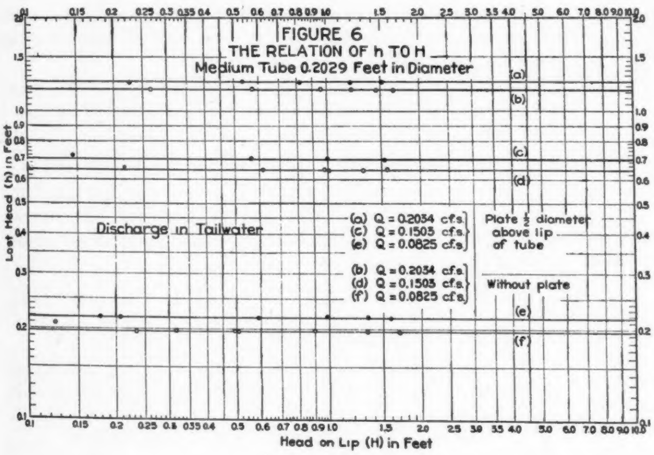
or

$$\log h/d = \log\ (h_1/d) - 0.0031 \log\ (H/d) \qquad [5a]$$

in which h_1/d is the value of h/d when H/d equals one diameter, regardless of the system of measure used for h, H, and d, but it is understood that these three are all measured in the same system. The quantity h_1/d is a constant for any given diameter, d, and for any given value of Q, but even for a constant diameter it is different for different values of Q. Hence this formula will not serve for the solution of all cases. It, therefore, still remains to develop a formula for h/d that will apply for all values of Q, for any diameter and for any value of H.

3 *The Relation between Q and h_1/d.* The constant value of the exponent of H/d in equation [5], that is, —0.0031 in all cases, seemed to indicate the possibility of a simple relationship between Q and h_1/d for a given size of tube. Hence, it was contemplated to plot the three standard values of Q under each size of tube against the corresponding values of h_1/d. However, it as once appeared that, if the generalized form expressed in dimensionless units were to be maintained, thus making any final formula estab-





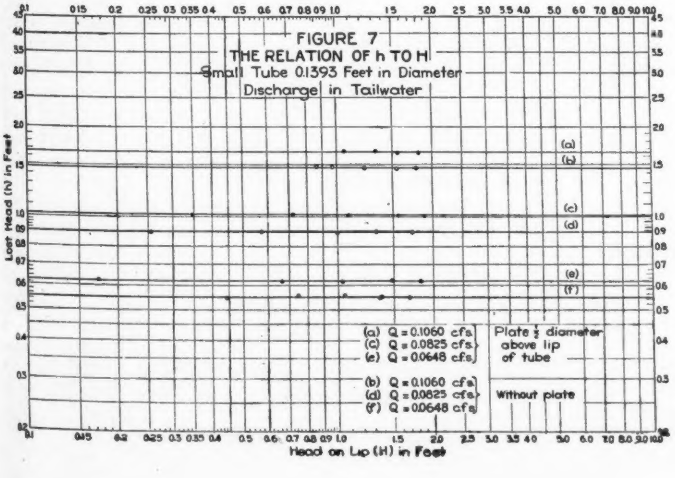
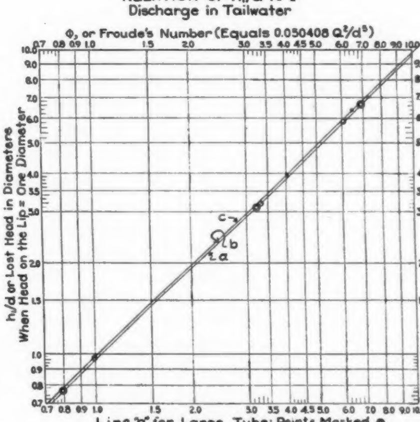


FIGURE 8
RELATION OF h_1/d to Φ
Discharge in Tailwater



Line "a" for Large Tube; Points Marked ⊙
Line "b" for Medium Tube; " " ○
Line "c" for Small Tube; " " •
Note:—Lines "a" and "b" too close together to show clearly as separate lines

FIGURE 9
RELATION OF k TO d
Discharge in Tailwater

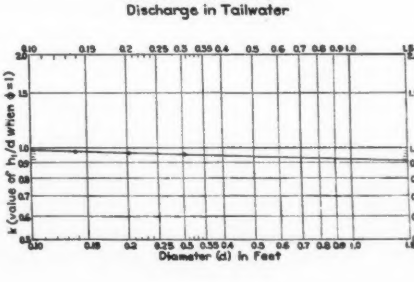


TABLE 5. RELATION BETWEEN h/d AND H/d obtained by transformation of the nine equations in Table 4

Q class	Algebraic formula	Corresponding logarithmic formula
	Large tube, $d = 0.3046$ ft	
High	$h/d = 6.6693\ (H/d)^{-0.0031}$	$\log (h/d) = \log 6.6693 - 0.0031 \log (H/d)$
Med.	$h/d = 3.0941\ (H/d)^{-0.0031}$	$\log (h/d) = \log 3.0941 - 0.0031 \log (H/d)$
Low	$h/d = 0.7628\ (H/d)^{-0.0031}$	$\log (h/d) = \log 0.7628 - 0.0031 \log (H/d)$
	Medium tube, $d = 0.2029$ ft	
High	$h/d = 5.8123\ (H/d)^{-0.0031}$	$\log (h/d) = \log 5.8123 - 0.0031 \log (H/d)$
Med.	$h/d = 3.1848\ (H/d)^{-0.0031}$	$\log (h/d) = \log 3.1848 - 0.0031 \log (H/d)$
Low	$h/d = 0.9708\ (H/d)^{-0.0031}$	$\log (h/d) = \log 0.9708 - 0.0031 \log (H/d)$
	Small tube, $d = 0.1393$ ft	
High	$h/d = 10.5489\ (H/d)^{-0.0031}$	$\log (h/d) = \log 10.5489 - 0.0031 \log (H/d)$
Med.	$h/d = 6.4355\ (H/d)^{-0.0031}$	$\log (h/d) = \log 6.4355 - 0.0031 \log (H/d)$
Low	$h/d = 3.9369\ (H/d)^{-0.0031}$	$\log (h/d) = \log 3.9369 - 0.0031 \log (H/d)$

lished generally applicable, it would be necessary that Q also be introduced into the argument in some form of pure number.

4 *Froude's Number and the Dimensionless Form for Q.* As it appears that the effect of internal friction on the flow through these short tubes is practically negligible in comparison with the force of gravity causing the flow, it is clear that, where there is complete similarity of occurrences between the three tubes, Froude's law of hydraulic similarity would apply. Owing to physical limitations in the laboratory set-up it was not possible, within any wide range of heads on the lip of the tube, and of lost head, to secure complete similarity. In any case, however, it was perfectly possible to compute the analogue of Froude's number ($\phi = v^2/dg$) for each occurrence for given, simultaneous values of all factors concerned. Through the relation $v = Q/a = Q/\frac{1}{4}\pi d^2$, ϕ is quite as readily expressed in terms of Q, d, and g, the expression taking the form (if g be given its numerical value of 32.16)

$$\phi = 0.050408 \frac{Q^2}{d^5}$$

This form has the double advantage of giving a dimensionless expression in which Q is involved as a factor, as desired, and of introducing gravity into the consideration through the factor g.

5 *Developing the Final Formula.* Therefore the value of ϕ for each tube and for each standard value of Q was computed by the formula just shown and plotted on logarithmic graph paper as abscissa against the corresponding value of h_1/d as ordinate. The sets of values of ϕ and of h_1/d thus computed and used are shown in Table 6 along with the values of h_1/d computed from the resulting equations and the per cent of variation of these computed values as compared with the plotted values from Table 5. The graphs are shown in Fig. 8. The equations for each tube resulting from scaling the graphs in Fig. 8 are as follows:

For the large tube, $\log h_1/d = \log 0.9554 + 1.0014 \log \phi$

For the medium tube, $\log h_1/d = \log 0.9631 + 1.0014 \log \phi$

For the small tube, $\log h_1/d = \log 0.9774 + 1.0014 \log \phi$

It will be noted that in each case the relationship takes the general form

$$\log h_1/d = \log k + 1.0014 \log \phi \qquad [6]$$

$$h_1/d = k\ \phi^{1.0014} \qquad [6a]$$

in which the value of the exponent of ϕ is constant, namely, 1.0014, but the value of k, which is the value of h_1/d when ϕ is unity, changes with the diameter. In order to determine the exact relationship between k and d, the values of k in the foregoing equations were plotted on logarithmic graph paper as ordinates against the corresponding values of d as abscissas. The graph thus obtained is shown in Fig. 9. Scaling of this graph gave the following equation:

$$\log k = \log 0.9184 - 0.031 \cdot \log d$$

This value of log k substantiated back in equation [6] gave

$$\log h_1/d = \log 0.9184 - 0.031 \log d + 1.0014 \log \phi \qquad [7]$$

The value of h_1/d given in equation [7] substituted back in equation [5a] gave

$$\log h/d = \log 0.9184 + 1.0014 \log \phi - 0.031 \log d - 0.0031 \log H/d \qquad [8]$$

If ϕ be replaced by its value, $0.050408\ Q^2/d^5$ equation [8] becomes

$$\log h/d = \log 0.9184 + 1.0014 \log (0.050408\ Q^2/d^5) - (0.031 \log d + 0.0031 \log H/d) \qquad [9]$$

or

$$h/d = 0.9184\ (0.050408\ Q^2/d^5)^{1.0014} \cdot d^{-0.031} \cdot (H/d)^{-0.0031} = 0.04610\ Q^{2.0028} \cdot d^{-5.0349} \cdot H^{-0.0031} \qquad [9a]$$

If equation [9a] be multiplied through by d, there results

$$h = 0.04610\ Q^{2.0028} \cdot d^{-4.0349} \cdot H^{-0.0031} \qquad [10]$$

which is an expression for lost head in terms of Q, d, and H, applicable to any case within the range of sizes of tube used in this study.

If it is preferred to express h in terms of v rather than Q, this may be done by substituting $\frac{1}{4}\pi d^2 v$ for Q in equation [10], and the result is

$$h = 0.02842\ v^{2.0028} d^{0.0293} H^{-0.0031} \qquad [11]$$

As it is frequently convenient to express lost head in terms of velocity heads, this may be done by successively multiplying and dividing the right-hand member of equation [11] by $v^2/2g$. There then results

$$h = 1.8279\ v^{0.0028} d^{-0.0293} H^{-0.0031} (v^2 g) \qquad [12]$$

TEST OF THE RELIABILITY OF FORMULA

It seems desirable in closing this part of the discussion to compare results obtained from the given data by the use

TABLE 6. RELATION BETWEEN h_1/d AND ϕ

Q in cfs	ϕ	k	h_1/d From Table 5	h_1/d Computed by formula*	Variation of computed from furnished value of h_1/d, per cent
		Large tube, $d = 0.3046$ ft			
0.6005	6.9323	0.9554	6.6693	6.6411	—0.42
0.4110	3.2467		3.0941	3.1070	+0.43
0.2034	0.7953	0.9554	0.7628	0.7596	—0.42
*Log $h_1/d = \log 0.9554 + 1.0014 \log \phi$					
		Medium tube, $d = 0.2029$ ft			
0.2034	6.0645	0.9631	5.8123	5.8555	+0.74
0.1503	3.3114		3.1848	3.1946	+0.31
0.0825	0.9977	0.9631	0.9708	0.9609	—1.02
*Log $h_1/d = \log 0.9631 + 1.0014 \log \phi$					
		Small tube, $d = 0.1393$ ft			
0.1060	10.7984	0.9774	10.5489	10.5896	+0.39
0.0825	6.4512		6.4355	6.4102	—0.39
0.0648	4.0355	0.9774	3.9364	3.9520	+0.40
*Log $h_1/d = \log 0.9774 + 1.0014 \log \phi$					

TABLE 7. CHECK EXAMPLES TO TEST THE RELIABILITY OF FINAL FORMULA 10

	h in feet			Variation of computed from observed values	
		Computed by			
H, in ft	Average of 5 observations	Formula 5	Formula 10	Formula 5, per cent	Formula 10, per cent
Large tube, $d = 0.3046$ ft					
High $Q = 0.6005$ cfs					
1.2640	2.0210	2.0225	2.0086	+0.08	—0.61
1.1250	2.0130	2.0233	2.0093	+0.51	—0.18
0.6395	2.0325	2.0268	2.0128	—0.28	—0.97
Medium $Q = 0.4110$ cfs					
1.0205	0.9360	0.9389	0.9405	+0.31	+0.48
0.7120	0.9360	0.9400	0.9416	+0.43	+0.60
0.4260	0.9510	0.9415	0.9431	—1.01	—0.83
Low $Q = 0.2034$ cfs					
1.2275	0.2325	0.2314	0.2298	—0.48	—1.16
1.0220	0.2315	0.2315	0.2299	0.00	—0.69
0.6055	0.2315	0.2319	0.2303	+0.17	—0.52
Medium tube, $d = 0.2029$ ft					
High $Q = 0.2034$ cfs					
1.4614	1.1710	1.1721	1.1831	+0.09	+1.03
1.2115	1.1745	1.1728	1.1837	—0.15	+0.78
0.5715	1.1755	1.1755	1.1865	0.00	+0.94
Medium $Q = 0.1503$ cfs					
1.5675	0.6485	0.6421	0.6453	—1.00	—0.49
1.3100	0.6400	0.6425	0.6457	+0.39	+0.89
0.9810	0.6430	0.6430	0.6462	0.00	+0.50
Low $Q = 0.0825$ cfs					
1.3363	0.1960	0.1958	0.1942	—0.10	—0.92
0.9013	0.1970	0.1961	0.1944	—0.46	—1.32
0.4924	0.1975	0.1964	0.1948	—0.56	—1.36
0.2365	0.1954	0.1969	0.1952	+0.76	—0.10
Small tube, $d = 0.1393$ ft					
High $Q = 0.1060$ cfs					
1.7905	1.4585	1.4579	1.4617	—0.04	+0.22
1.2200	1.4580	1.4596	1.4634	+0.11	+0.37
0.8630	1.4660	1.4613	1.4651	—0.32	—0.06
Medium $Q = 0.0825$ cfs					
1.7230	0.8895	0.8895	0.8849	0.00	—0.52
0.9975	0.8825	0.8910	0.8864	+0.95	+0.44
0.5740	0.8885	0.8925	0.8880	+0.45	—0.06
Low $Q = 0.0648$ cfs					
1.6825	0.5460	0.5441	0.5456	—0.35	—0.07
1.3495	0.5445	0.5445	0.5460	0.00	+0.28
1.0495	0.5515	0.5449	0.5464	—1.20	—0.93
0.4430	0.5425	0.5464	0.5479	+0.71	+0.99

of equation [10] with the observed values of *h* given in the tables, covering the cases of all 3 tubes without plate, as a test of the reliability of equation [10] within the limits of the physical set-up of this study. There have therefore been selected from the tables, from among those averages of observed values of *h*, three from each *d* and *Q* class and these, together with the corresponding values computed by formula [10] are shown in Table 7. For the purposes of this test, in choosing the individuals in each set of three averages of observed values of *h*, it was aimed in each case, as a rule, to select the item that showed the greatest variation from the value computed by the mathematical relation between *h* and *H* expressed in the general form of equation [5], the value that showed the least variation from the value thus computed, and one value showing a corresponding variation as nearly intermediate between the two extremes as possible.

In Table 7 the per cents of variation of the values computed by formula [10] from the averages of observed values are not so satisfying as are the per cents of variation from the computations by formula [5] for each size of tube and *Q* class. Nevertheless the extreme variations shown in Table 7 mostly fall within what may be considered a reasonable range in practice.

SUMMARY AND CONCLUSIONS

1 The experiments herein discussed indicate that open vortex occurrence can not be effectively controlled in practice by submerged or partially submerged baffles set vertically to intercept longitudinal or rotational flow of water. As open vortex formation seems ultimately to result from a combination of rotational flow of the water in corkscrew fashion downward to the outlet and of atmospheric pressure on the surface, its logical primary control seems to be in the surface plane. Hence, prevention of the direct pressure of the atmosphere upon successive differential vertical sections of the whirling and sinking water seems the logical method of attack. The approximate maximum radius of orbit of vortices seems to be about four diameters of the culvert.

2 A square, light, wooden float four diameters on a side is effective in all cases tried in eliminating vortex occurrence, and except for relatively very low heads on the lip of the culvert does not increase the loss of head.

By preventing the formation of open vortex and the resultant increase in internal pressure that causes rapid rise in lost head, such a float also has appreciable effect in limiting the height to which head will develop over the culvert for any given set-up.

3 Within the physical limits of the apparatus used in this study, and with particular reference to the diameters of tube used, the value of lost head for lengths of tube of approximately five and a half diameters is expressed apparently within a fair range of accuracy, in terms of *Q*, *d*, and *H*, by equation [10]:

$$h = 0.04610\ Q^{2.0028} d^{-4.0349} H^{-0.0031}$$

or, in terms of *v*, *d*, and *H*, by equation [11]:

$$h = 0.02842\ v^{2.0028} d^{-0.0293} H^{-0.0031}$$

or, in terms of *d*, *H*, and velocity heads by equation [12]:

$$h = 1.8279\ v^{2.0028} d^{-0.0293} H^{-0.0031} (v^2/g).$$

4 To assume that these formulas are applicable beyond sizes of tube and values of head on the lip in diameters used in this study, to tubes of any diameter and for all values of head on the lip, may not be fully warranted owing to limited extent of the tests and to small diameters of tubes tested.

5 Therefore, more extended experimentation is desirable, the more fully to establish the law applicable to all cases. It seems to the author that such additional research should cover physical tests with a number of tubes of increasingly greater diameter and with heads on the lip relatively much higher than were employed in these tests.

It will probably also be desirable to modify the procedure on at least a part of such additional tests by keeping the head on the lip constant and varying the discharge, thus more directly uncovering the relation between *Q* and *h*. It will also probably be desirable to provide, as nearly as possible, for similarity of conditions as between the different sizes of tubes. Such additional tests would furnish a basis for a much more complete and searching mathematical analysis of the phenomena occurring with this type of inlet than could possibly be the case in this study where the points on the logarithmic graphs of the various relationships were frequently limited to three, which is the very minimum number permitting of this type of analysis.

In this connection the author believes that it would be desirable to extend the tests to cover tubes of one foot, two feet, and, possibly, also three feet in diameter with heads on the lip at frequent intervals between one-half diameter and at least seven or eight diameters when it may prove possible to secure such a set-up. He realizes, however, that the upper limit of such a set of tests could probably be made available only in some actual field lay-out where complete control of all elements and factors might be difficult or even impossible.

What Agricultural Engineers Are Doing

REPORTED FROM USDA BUREAU OF AGRICULTURAL ENGINEERING

ON SEPTEMBER 9 S. H. McCrory, chief of the Bureau, accompanied by C. A. Bennett and R. C. Young, conferred at Memphis, Tennessee, with Mack Rust, one of the inventors of the Rust Brothers cotton picker. They then went to Stoneville, Miss., where a demonstration of the picker was made before a large number of visitors at the Mississippi Delta Branch Experiment Station. At the conclusion of the demonstration, cooperative arrangements were made between the Bureaus of Agricultural Engineering and Agricultural Economics and the Mississippi Delta Branch Experiment Station for more thorough tests which will include the ginning of mechanically harvested samples and the spinning of certain select lots of ginned fiber.

* * *

A research program, to be conducted in conjunction with the drainage camps, was begun during the past month. The program includes the establishment of ditch slope courses from which will be determined the value of n for open channels, the effect of carrying capacity of the ditch due to varying conditions of vegetation and maintenance, as well as maintenance costs under these various conditions. It is intended to determine the most economical methods of maintenance.

* * *

In connection with the irrigation water-supply forecasting project, J. C. Marr made arrangements for establishing a snow-survey and water-supply program for Montana, northern Idaho, and Washington. Snow surveys in these three states will have value in connection with large water-control and water-storage works along the Columbia, Missouri, and Mississippi Rivers, such as at Grand Coulee, Bonneville, and Fort Peck. Mr. Marr and L. T. Jessup established 18 snow survey courses in Washington and Oregon. George D. Clyde laid out 23 courses in central southern Utah, and Carl Rohwer made arrangements with the Weather Bureau and the Soil Conservation Service for establishment of snow courses on the principal streams of New Mexico. Tentative locations were selected for 10 courses on tributaries of the Rio Grande and the headwaters of Pecos and Canadian Rivers. R. A. Work also established four courses on the Umpqua River watershed, Oregon.

* * *

In the Rio Grande Valley investigation for the National Resources Committee, the work of mapping the vegetative cover of San Luis Valley continued under the supervision of Carl Rohwer. To date 475,000 acres have been mapped, most of which is in the irrigated section. Over 1200 aerial photographs of the valley floor were made by a commercial aerial survey company, to be used in mapping the vegetative cover. In New Mexico, under the supervision of Fred C. Scobey, the mapping of the tributary streams entering the Rio Grande from the east continued, the areas including several Indian pueblos. O. W. Israelsen prepared estimates of the net consumptive use of different crops in Mesilla Valley, also determinations of consumptive use for the entire valley by the inflow-outflow method. A study was also made of water-supply data, irrigation-area surveys, water-depletion studies, and estimates of net consumptive use in San Luis Valley as a basis for arriving at the consumptive use for the valley as a whole and for major tracts within the valley.

Contributions Invited

All public-service agencies (federal and state), dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

* * *

Plans for the season's work on the project "storage of water underground", which is being carried on by A. T. Mitchelson and Dean C. Muckel, include the installation of an additional water-spreading plot near Azusa, California. It has been found that percolation rates are influenced greatly by a fluctuating high water table which occurs during certain periods of the spreading season at the canyon plots. The new plot will be located outside the limits of the canyon groundwater basin, in the main groundwater basin of the San Gabriel River Valley, where the water table stands at more than 200 ft below the ground surface at all times. Percolation rates on the new plot will be compared with rates on the canyon plots.

* * *

Tests on the Urschel-Scott Viner sugar-beet harvester conducted in California during the past month by E. M. Mervine and S. M. McBirney have shown the machine to be considerably improved since last year. Beets were successfully harvested in three localities in the lower Sacramento Valley. A new type of lifting and elevating chain using rubber inserts in the chain links was very effective and caused no trouble. The new power take-off shaft eliminated difficulties encountered last year. The machine seemed to do a better job of getting the beets under favorable conditions as there were fewer misses in the row than heretofore. The topping, like that done last year, was comparable with hand work. Some improvements, particularly in dead-leaf separation from the beets, are still necessary.

* * *

A fruit transit test just completed, from California to New York, in which W. V. Hukill participated, was run mainly for the purpose of comparing the effectiveness of the new refrigerator cars having 3 in of insulation, with the older type of car with less insulation. There was between 10 and 20 per cent less heat loss through the wall in the new car, but very little difference in fruit temperatures. Ice meltage was, of course, greater in the older cars. Upper half bunker icing, which was tested in making this shipment, was further shown to be an economical method of refrigeration.

* * *

During the past month Circular 399, "Machine Placement of Fertilizers for Snap Beans in Florida", was published; and Farmers' Bulletin 1045, "Laying out Fields for Tractor Plowing," was revised.

REPORTED FROM AGRICULTURAL ENGINEERING DEPARTMENT, UNIVERSITY OF CALIFORNIA

CALIFORNIA produces annually several million pounds of both large and small lima beans for seed purposes. During recent years much difficulty has been experienced, particularly in the East, in securing good stands of lima beans because of poor germination of the seed. Investigations have shown that the cause is due to mechanical injury during threshing and handling.

In an endeavor to reduce this damage to seed beans during the threshing operation, Roy Bainer and J. S. Winters are developing a machine to roll and squeeze the bean plant to break up the pods and work out the beans.

This machine consists of three sets of copper covered steel rolls, approximately 12 in in diameter, mounted in pairs, with the centers of each pair approximately 4 ft apart. The lower roll of each pair is positively driven and the upper rolls are driven by contact with the lower rolls, or through the bean straw passing between them.

By separating the sets of rolls, space is available for separating the threshed beans from the straw so that they do not pass through the next set of rolls. The separating chamber and cleaning shoe are built according to standard construction found in commercial threshers.

* * *

Pest control continues to demand new materials and new methods of application. In order to meet these demands a duster is being developed to apply various kinds of insecticidal dusts on citrus trees. Dust is applied to the tree by means of a nozzle discharging vertically from underneath the foliage and also by a hand-operated nozzle covering the outside of the tree. A large volume of air at relatively low pressure is utilized. O. C. French is responsible for this development.

* * *

A statewide survey of the character of dust in the air raised by field implements is now being made by F. A. Brooks and J. P. Fairbank. Twenty major centers of power farming in California have been investigated. Samples of dust clouds were caught in sedimentation cans with prepared microscope slides. Microscope work is well under way. Surface soil samples were obtained for soil-moisture determination and for subsequent gravimetric analysis to determine particle-size distribution of the silt and clay portions. One-gallon samples were also procured for later laboratory dust-making and chemical analyses.

* * *

Two California sites are being prepared as test plots for the American Society for Testing Materials cooperative project on farm fencing. *(Continued on Page 488)*

PROGRAM

Winter Meeting of the American Society of Agricultural Engineers

The Stevens, Chicago, Illinois November 30 to December 4, 1936

MONDAY, NOVEMBER 30 — 2:00 to 4:00 p. m.

(I) FARM STRUCTURES DIVISION

Presiding: *K. J. T. Ekblaw,* American Zinc Institute

Farm Storage of Grain—A symposium led by *Wallace Ashby,* Bureau of Agricultural Engineers, USDA (20 min.)

Discussions on Grain Storage Investigations (5 min. each):

(a) In Kansas — *F. C. Fenton,* Kansas State College
(b) In Illinois — *W. A. Foster,* University of Illinois
(c) In North Dakota—*H. F. McColly,* N. D. State College
(d) In Maryland—*R. D. Carpenter,* University of Maryland, and *M. A. R. Kelley,* Bureau of Agricultural Engineering, USDA
(e) In Ohio — *R. C. Miller,* Ohio State University
(f) General Summary—*B. M. Stahl,* Bureau of Agricultural Engineering, USDA; *W. B. Combs,* Bureau of Agricultural Economics, USDA; *Dr. A. G. Johnson,* Bureau of Plant Industry, USDA.

(II) POWER AND MACHINERY DIVISION

Presiding: *O. E. Eggen,* division chairman

1 Recent Progress in Farm Machinery Research — *R. W. Trullinger,* Office of Experiment Stations, USDA (20 min.)
2 Testing Tractor Wheels and Lugs — *J. W. Randolph,* Bureau of Agricultural Engineering, USDA (30 min.)
3 Tests of Tillage Tools: (1) Equipment and Procedure for Moldboard Plows—*I. F. Reed,* Bureau of Agricultural Engineering, USDA (30 min.)
4 Making Use of Force Measurements on Tillage Tools—*A. W. Clyde,* Pennsylvania State College (10 min.)

* * *

MONDAY, NOVEMBER 30 — 7:30 p. m.

(I) FARM STRUCTURES DIVISION

Midwest Farm Building Plan Service — A round table led by *E. R. Jones,* University of Wisconsin

(II) COMMITTEE AND GROUP ROUND TABLES BY ARRANGEMENT

* * *

TUESDAY, DECEMBER 1 — 9:30 to 11:30 a. m.

(I) FARM STRUCTURES DIVISION

Presiding: *A. M. Goodman,* division chairman

1 Instruments for Farm Structures Research — *W. V. Hukill,* Bureau of Agricultural Engineering, USDA (20 min.)
2 Essential Qualities of Wall Filling Insulation for Farm Buildings—*W. M. Rees,* U. S. Gypsum Co. (20 min.)
3 The Poultry Housing Problem—*F. L. Fairbanks,* Cornell University (20 min.)

(II) POWER AND MACHINERY DIVISION

Presiding: *O. E. Eggen,* division chairman

Agricultural Requirements of the Small Type All-Purpose Tractor — A Symposium

(a) From the Tractor Engineer's Viewpoint — *B. R. Benjamin,* International Harvester Co. (10 min.)
Discussion: *C. E. Frudden, Allis-Chalmers Mfg.* Co. (5 min.)
(b) From the Implement Engineer's Viewpoint—*J. R. Orelind,* Minneapolis-Moline Power Implement Co (10 min.)
Discussion: *D. C. Heitshu,* J. I. Case Co. (5 min.)
(c) From the Broad Agricultural Engineering Viewpoint (A series of brief discussions by agricultural engineers in public service)

* * *

TUESDAY, DECEMBER 1 — 2:00 to 4:00 p. m.

(I) FARM STRUCTURES DIVISION

Presiding: *A. M. Goodman,* division chairman

1 Engineering Problems in Air Conditioning—*Samuel R. Lewis,* consulting engineer and specialist in air conditioning, Chicago (20 min.)
Discussion: *S. A. Witzel,* University of Wisconsin (10 min.)
2 The Measurement of Air Conditions in Farm Homes—*J. W. Simons,* Bureau of Agricultural Engineering, USDA, and *F. B. Lanham,* University of Georgia (20 min.)
Discussion: *E. C. Meyer,* University of Wisconsin, and *M. J. La Rock,* Bureau of Agricultural Engineering, USDA (5 min. each)
3 Prevention of Silo Gas Accidents — *Dr. D. J. Price* and *H. E. Roethe,* Bureau of Chemistry and Soils, USDA (15 min.)

(II) POWER AND MACHINERY DIVISION

Presiding: *Frank. J, Zink,* Allis-Chalmers Mfg. Co.

1 Today's Challenge to the Engineers — *H. C. Merritt,* chairman, executive committee, Farm Equipment Institute (30 min)
Response: *R. U. Blasingame,* President, American Society of Agricultural Engineers (20 min.)
2 Farm Machinery Trends in Europe—*R. B. Gray,* Bureau of Agricultural Engineering, USDA (30 min)

* * *

TUESDAY, DECEMBER 1 — 7:30 p. m.

COMMITTEE AND GROUP ROUND TABLES BY ARRANGEMENT

* * *

WEDNESDAY, DEC. 2 — 9:30 to 11:30 a. m.

(I) FARM STRUCTURES DIVISION

Presiding: *A. M. Goodman,* division chairman

1 The Place of Steel in Farm Building Construction — *Earl A. Anderson,* Republic Steel Corp. (15 min.)
2 Farm Insurance Rates as Affected by Types of Construction — *Dr. V. N. Valgren,* insurance division, Farm Credit Administration (20 min.)
3 Interior Arrangement and Design of Farm Homes — *Miss Ellen Pennell,* "The Country Home" (20 min.)
Discussion: *Miss Ruby E. Loper,* University of Nebraska (10 min.)

(II) POWER AND MACHINERY DIVISION

Presiding: *Frank. J. Zink*

1 1936 Field Studies of the Small Combine—*W. M. Hurst,* Bureau of Agricultural Engineering, USDA (15 min.)
2 Rootbed Preparation vs. Seedbed Preparation — *G. D.* Jones, Cleveland Tractor Co. (15 min.)

3 Removal of Spray Residue from Farm Products—*H. G. Ingerson*, John Bean Mfg. Co. (15 min.)
Discussion: *R. H. Reed*, University of Illinois (5 min.)

4 Vapor Spraying for Insect Control—*E. L. Nixon*, Pennsylvania State College (15 min.)
Discussion: *R. M. Merrill*, Bureau of Agricultural Engineering, USDA (5 min.)

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WEDNESDAY, DEC. 2 — 2:00 to 4:00 p. m.
FARM STRUCTURES DIVISION AND POWER AND MACHINERY DIVISION
Presiding: *F. W. Duffee*, University of Wisconsin

Chopped Hay and Hay Silage Processing and Storage — A Symposium

(a) Chopped Hay and Hay Silage Developments — *W. H. Peterson*, University of Wisconsin (25 min.)
(b) The Storage of Chopped Hay in Ventilated Containers—*S. A. Witzel*, University of Wisconsin (15 min.)
(c) Two Types of Concrete Dairy Stable—*R. G. Ferris*, Starline, Inc. (10 min.)
(d) Spontaneous Combustion of Chopped Hay—*H. H. Musselman*, Michigan State College (10 min.)

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THURSDAY, DEC. 3 — 9:30 to 11:30 a. m.
(I) SOIL AND WATER CONSERVATION DIVISION
Presiding: *C. E. Ramser*, division chairman

1 Water Conservation Engineering Program of the Soil Conservation Service in the Northern Great Plains States — *L. C. Tschudy*, Soil Conservation Service, USDA (20 min.)

2 Wind Erosion and Its Control in the Great Plains Region —*R. R. Drake*, Soil Conservation Service, USDA (20 min.)

3 Hydrologic Measuring Equipment and Its Installation on the Watershed and Hydrologic Project at Coshocton, Ohio — *W. D. Ellison*, Soil Conservation Service, USDA (20 min.)

(II) RURAL ELECTRIC DIVISION
Presiding: *W. J. Parvis*, Public Service Co. of Indiana

1 Looking Ahead in Rural Electrification—*J. P. Schaenzer*, Committee on the Relation of Electricity to Agriculture (20 min.)

2 The Electrification of a Fruit Farm—*Truman E. Hienton*, Purdue University (20 min.)

3 Swedish Rural Electrification Motion Picture—Courtesy of Rural Electrification Administration (30 min.)

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THURSDAY, DEC. 3 — 2:00 to 4:00 p. m.
(I) SOIL AND WATER CONSERVATION DIVISION
Presiding: *C. E. Ramser*, division chairman

1 Farm Operating Efficiency—*G. R. Boyd*, Bureau of Agricultural Engineering, USDA (15 min.)

2 Agricultural Engineering in the Shelter Belt — *I. D. Wood*, University of Nebraska (15 min.)

3 Supplemental Irrigation in the Humid Region — *F. E. Staebner*, Bureau of Agricultural Engineering, USDA (15 min.)

4 Research Work Carried on in Connection with CCC Drainage Camps — *L. A. Jones*, Bureau of Agricultural Engineering, USDA (15 min.)

(II) RURAL ELECTRIC DIVISION
Presiding: *Geo. A. Rietz*, division chairman

1 The Challenge of Rural Electrification to the Agricultural Engineer — *Grover C. Neff*, Wisconsin Power and Light Co. (20 min.)

Discussions:
(a) Past Performance of Agricultural Engineers in Rural Electrification—*E. C. Easter*, Alabama Power Co. (15 min.)
(b) The Job Ahead in Rural Electrification for Agricultural Engineers—*E. A. White*, Committee on the Relation of Electricity to Agriculture (15 min.)

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THURSDAY, DECEMBER 3 — 7:30 p. m.
(I) SOIL AND WATER CONSERVATION DIVISION
Presiding: *C. E. Ramser*, division chairman

Committee reports and round table discussion

(II) RURAL ELECTRIC DIVISION
Presiding: *C. C. Bell*, Wisconsin Public Service Co.

Building Load on Rural Lines — A Symposium led by *J. H. Gallagher*, Consumers Power Co.

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FRIDAY, DECEMBER 4 — 9:30 to 11:30 a. m.
(I) SOIL AND WATER CONSERVATION DIVISION
Presiding: *C. E. Ramser*, division chairman

1 Results of Experiments on the Flow of Water through Drop Inlet Culverts and Other Erosion Control Structures — *L. H. Kessler*, professor of hydraulic engineering, University of Wisconsin (20 min.)

2 Recommendations for Terrace Design Based on the Results of Experiments at the Statesville Erosion Experiment Station—*F. O. Bartel*, Soil Conservation Service, USDA (20 min.)

3 Use of Drop-Inlet, Soil-Saving Dams in the Wisconsin Soil Conservation Program—*E. R. Jones*, University of Wisconsin (20 min.)

(II) RURAL ELECTRIC DIVISION
Presiding: *I. P. Blauser*, Ohio State University

1 Economic Rural Line Construction Practices — *H. C. Bartholomew*, Illinois Northern Utilities Co. (20 min.)

2 How Agricultural Engineers Can Best Cooperate with the REA Program — *Oscar Meier*, Rural Electrification Administration (20 min.)

3 My Ideas on the Farm Wiring Job — *C. P. Wagner*, Northern States Power Co. (20 min.)

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FRIDAY, DECEMBER 4 — 2:00 to 4:00 p. m.
(I) SOIL AND WATER CONSERVATION DIVISION
Presiding: *C. E. Ramser*, division chairman

1 Methods and Cost of Terrace Construction with a Discussion of Influencing Factors — *T. B. Chambers*, Soil Conservation Service, USDA (20 min.)

2 Terrace Cross Sections as Influenced by Soil, Crops, Land Slopes, and Farm Machinery — *A. T. Holman*, Bureau of Agricultural Engineering, USDA (20 min.)

3 Relative Cost and Effectiveness of Different Methods of Terrace Outlet Control—*Howard Matson*, Soil Conservation Service, USDA (20 min)

(II) RURAL ELECTRIC DIVISION
Presiding: *Geo. A. Rietz*, division chairman

1 Applying Electricity to Seed Corn Drying—*F. W. Duffee*, University of Wisconsin (20 min.)

2 Rural Electrification Trends in Europe — *R. B. Gray*, Bureau of Agricultural Engineering, USDA (20 min.)

3 Electric Service on the Dairy Farm — *Harold Bingham*, manager, Buffalo Creek Farm (20 min.)

Southern Section Meeting at Nashville

A FULL DAY and two additional afternoons are scheduled for sessions of the Southern Section of the American Society of Agricultural Engineers, meeting in conjunction with the Southern Agricultural Workers, at Nashville, Tennessee, February 3, 4, and 5, 1937. The sessions of this meeting will be held at the Andrew Jackson Hotel.

R. U. Blasingame, president of the ASAE, is scheduled to address the opening session on the afternoon of February 3. J. B. Wilson, chairman of the Section, will preside over this session. A paper on "The Organization of Agricultural Engineering in the Southeast," is to be presented by M. L. Nichols, and discussed by H. T. Barr. Another paper on "Farm Machinery in a Terracing Program," by W. A. Clegg, is to be discussed by M. A. Jones. Announcement of committee appointments is also scheduled for this session.

At a joint session of the Section with the forestry and agronomy sections of the Association of Southern Agricultural Workers, to be held the morning of February 4, E. G. Diseker is to present a paper on "A Study of Runoff Velocities Under Varying Conditions."

During the afternoon of the same day Mr. Nichols will preside over a session on soil conservation. Papers and discussions scheduled are "The Experiment Station Engineer in a Soil Conservation Program," by A. Carnes, discussion by C. E. Seitz; "The Extension Service in a Coordinated Soil Conservation Program," by S. P. Lyle, discussion by G. E. Martin; and "The Coordination of Engineering Phases of Soil Conservation Service with Other Agencies in the Field," by T. B. Chambers, discussion by C. J. Hutchinson.

Rural home improvement will be featured in the closing session of the Section, on the afternoon of February 5. In this session at which R. H. Driftmier will preside, J. W. Simons will present a paper on "A Low Cost Farm Housing Project," to be discussed by H. W. Dearing, Jr.; and George W. Kable will present "Electricity and Its Uses on the Farm," to be discussed by D. S. Weaver.

An election of new officers for the Section is to be held at the close of this session.

Georgia Section ASAE Organized

NEARLY every ASAE member in Georgia attended the organization meeting and banquet of the Georgia Section of the American Society of Agricultural Engineers, held Saturday evening October 17, at Dawson Hall on the agricultural campus of the University of Georgia at Athens..

R. H. Driftmier was elected chairman of the Section. Others officers elected were C. W. Chapman, vice-chairman, and W. N. Danner, Jr., secretary-treasurer.

Mr. Driftmier was toastmaster at the banquet. A short business meeting, in which organization of the Section was completed, was first on the program. Another feature of the program was an address by W. C. Chapman on "Opportunities for the Young Agricultural Engineer."

Wives and lady friends of the agricultural engineers were present.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

IN THE unavoidable failure to accomplish the impossible task set in the program for the Upstream Engineering Conference, the Conference was not without value to interested parties in federal and private service. It did not effect a consolidation of all available information concerning soil and water conservation and pertinent techniques; but encouraging emphasis was placed upon the need for a more general use of sound engineering based upon complete hydrological data, and much evidence was submitted supporting the necessity for united engineering action and coordinated enabling legislation by the citizens of the political subdivisions lying within any drainage area or river system to overcome hindrances frequently imposed by personal differences or prejudices and state and county boundaries.

No basic differences were disclosed between upstream and downstream engineering. On the contrary, this meeting of minds seemed to dramatize their related values, and to crystallize appreciation of the necessity for united technical, economic, and political action in each watershed, with reference to the conservation and utilization of soil, water, and other natural resources. One of the chief values of the meeting was the presentation by the several departments of the government including Agriculture, Army, Forestry, Geological Bureau, Power (represented by TVA and the Rural Electrification Administration) and the Weather Bureau of their specific observations and opinions to a common audience. After the several viewpoints had been presented and discussed, Morris L. Cooke made a strong case for the reconsideration of the whole program of water control on the basis of coordination of the knowledge and activities of the various government agencies and recommended the creation of a group of interstate regional areas constituting the drainage basins for our river systems. No action was taken, but comment seemed to favor the interstate regional proposition as a practical means of providing enabling coordinated action on water control and water use from the viewpoint of areas as a whole rather than independent communities.

Similar concepts of approach to the practical solution of such conservation and utilization problems, and to the inauguration of workable programs, are to be found in the minds of a number of prominent engineers, some of whom had rather definitely defined ideas prior to the Upstream Engineering Conference. As a matter of fact, recognition of natural areas in dealing with water power policy, flood control, water resources, etc., has been a part of earlier reports on these subjects by American Engineering Council's committees. American Engineering Council's committee on Conservation and Utilization of Natural Resources already has a study under way which is expected to provide practical suggestions for engineers who are interested in or may be engaged in the organization and administration of regional entities involving more than one state.

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As a part of its water resources committee's program, the National Resources Committee invited and paid the expenses of a number of prominent engineers and engineer representatives of engineering organizations to a meeting of its own on water resources paralleling the Upstream Engineering Conference. There was no conflict because this delegation attended the directly related sessions of the Upstream Engineering Conference and some of the discussion carried over from meeting to meeting. Excellent practical comparisons of opinions and experiences were made, but the feature of the water resources symposium was the enlightening report of Abel Wolman of Baltimore for the water resources committee of the National Resources Committee. Mr. Wolman effectively outlined their understanding of their objectives, summarized their activities to date, and stressed their recognition of the need for real cooperation in their effort to coordinate a mass of valuable information on water resources, conservation, and use. Nothing really new developed from this meeting, but the Committee made a direct bid to engineers in private practice as well as those in public service for advice and assistance in the preparation of information to be made available to everyone who may increase its usefulness. In connection with the practical use of such information, this meeting also stressed the value of interstate compacts or regional action without hindrance to administration by differences between political subdivisions.

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Rural Electrification Administration's release dated August 5 reported receipt of letters from the American Farm Bureau Federation, National Grange, and the Consumers Association, urging the electrification of farm *(Continued on page 488)*

Missouri Student Branch

OFFICERS of our Branch this year are president, Ralph Ricketts; vice president, Vernon Wood; and secretary-treasurer, Joe Park.

Our first meeting this year was held on Tuesday evening, September 22. At this meeting Wilmo Junnila, a graduate student here who obtained his degree last year from the University of Minnesota, gave a talk on the economic possibilities of the farmer contracting part of his work done, as compared to doing it himself, with either diesel or gasoline power. There was also a discussion of the ASAE meeting at Estes Park this summer. Prof. J. C. Wooley, our faculty adviser, suggested that the Branch hold a speaking contest this year, similar to the one held last year, in which each upperclassman gave a talk on a subject of common interest to the Branch. The two men giving the best talks were presented with prizes the end of the year at the annual banquet. His suggestion was adopted.

At the second meeting October 13, two films were shown. The titles of these films were: "Irrigation" and "The Arid Southwest." Plans were made for a picnic to be held October 20. It is sponsored by the faculty of the agricultural engineering department. About thirty members are expected to attend. They will meet at the agricultural engineering building at the specified time and proceed from there to the Beasley Farm, owned by the University and situated about three miles out of town. After eating, the members of the Branch will each briefly relate their activities of the past summer.—*Reported by Joe Park.*

What Agricultural Engineers Are Doing

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One is at the College of Agriculture, Davis, adjacent to a ten-year-old test plot of fence posts erected by J. D. Long. This site features conditions typical of the interior agricultural valleys of the state. The second site is at Santa Cruz, about three miles from the coast, where the exposure conditions are typical of coastal regions.

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Comparative tests of various types of asphaltic floors and pavements suitable to farm use are being conducted by J. D. Long and H. L. Belton. Livestock men evidence a considerable interest in this subject.

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With a short daily service period, 2 to 8 hr, the heat absorbed by the refrigerant fluid from pipe line insulation of standard-practice thickness, is large in proportion to the leakage heat absorbed by the surroundings. The influence of insulation heat capacity is being evaluated by R. L. Perry and W. P. Berggren in order to prepare recommendations for economic insulation thickness for intermittent service.

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Field tests on a beet harvester using the principle of lifting and topping were conducted during the past season by S. W. McBirney and E. M. Mervine of the USDA Bureau of Agricultural Engineering in cooperation with the California station. Encouraging results were obtained.

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B. D. Moses and J. P. Fairbank have concluded field studies of walnut dehydration practice when using the Brown multistage type of dehydrator both with and without the use of ethylene gas treatment. These dehydrators were built from plans prepared by H. B. Walker and B. D. Moses, following field and laboratory studies made in previous years in cooperation with the USDA Bureau of Chemistry and Soils, the University agricultural extension service, University of California division of fruit products, and the California Walnut Growers Association.

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property on the premise that "electrified farms attract a higher type of tenant, reduce tenant turnover, lower fire hazards, and increase the saleable price of the property."

At the time of its change from an emergency to a permanent agency as of August 1, 1936, the Rural Electrification Administration reported that a total of 35 projects involving $14,960,728.50 had been financed from funds heretofore made available under the Emergency Relief Appropriation Act of 1935. Henceforth, the Rural Electrification Act provides that loans made for the fiscal year ending June 30, 1937 will be financed with funds obtained through the Reconstruction Finance Corporation. Subsequent reports of allocations bring the total volume of business done by Rural Electrification to more than $20,000,000 on over 100 projects, including approximately 20,000 miles of distribution lines to serve some 75,000 customers who have never before had electricity.

Rural Electrification Administration also reports that its first demonstration farm near Herndon, Virginia, has proven so valuable that plans are being made to electrify a number of typical farms in other parts of the country for exhibition purposes. Such farms are intended to demonstrate the various uses of electricity on the farm and in the rural home and to guide new customers in selecting their own electrical appliances. Florida, Indiana, North Carolina, Ohio, and Virginia are among the states already included in the plans for this promotion of rural electrification.

* * *

National Resources Committee released an interim report some weeks ago by its research committee on urbanism. It is a relatively large volume of information on urban life representing several months work by the committee under the chairmanship of Clarence Dykstra of Cincinnati. The survey discloses a lack of factual information regarding trends of life in our cities and recommends the accumulation of basic facts, the collection of relevant information, and a funding of knowledge with respect to the major emerging unsolved questions of national urban policy. The report and its suggestions are pointed toward the technical improvement of official statistics, the enhancement of their use, and the elimination of duplicating effort among government agencies, and between government and national associations of public officials and social organizations.

Other National Resources Committee releases indicate a large variety of activities in that organization, but the one of perhaps most interest to engineers reports the preparation of a national budget at the request of Secretary Ickes for a proposed six-year program of public construction. A survey of public construction needs is being conducted through the 46 state planning boards who are sending printed forms to local officials of political subdivisions. The forms are to be filled out within the next few weeks and engineer citizens interested in public construction budgets will probably find local officials and sponsoring agencies responsive to suggestions and advice. In addition to the questions affecting choice of projects the problem of substituting long term planning on public construction for decisions on the annual basis is up for serious consideration. The implied aim is the adoption of long term planning to eliminate waste and duplication by bringing about closer cooperation between all construction agencies.

ASAE Meetings Calendar

November 30 and December 1 to 3—Power and Machinery Division, Rural Electric Division, Farm Structures Division, and Soil and Water Conservation Division (individual and joint programs)—Stevens Hotel, Chicago.

February 3 to 5, 1937—Southern Section (in conjunction with annual convention of the Association of Southern Agricultural Workers)—Nashville, Tenn.

June 21 to 24, 1937—Annual meeting of the Society—University of Illinois, Urbana-Champaign.

Personals of ASAE Members

Harry L. Garver, specialist in rural electrification, State College of Washington, is on a year's leave to take advance engineering work in electricity and irrigation at the University of California.

Eugene G. McKibben is on a leave of absence from Iowa State College until next June, and is associated with the national research project division of the Works Progress Administration. The project on which he is engaged is the study of reemployment opportunities and recent changes in industrial techniques. He is serving as agricultural engineer for a section of the project which is making a survey of effects of changing agricultural techniques on employment in agriculture.

Earl R. Young, formerly with the U. S. Soil Conservation Service at Spring Valley, Minnesota, has been appointed an instructor in agricultural engineering at the University of Kentucky, Lexington.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

George Bell, rural engineer, Georgia Power Co., Athens, Ga. (Mail) 153 Morton Ave.

Jesse B. Brooks, extension agricultural engineer, University of Kentucky, Lexington, Ky. (Mail) 147 Washington Ave.

E. Robert Curry, rural representative, Philadelphia Electric Co., West Chester, Pa.

William C. Davis, retail and rural salesman, Southern Pennsylvania Power Co., Oxford, Pa.

Cornelius W. Friedrichsen, repair man, International Harvester Co. (Mail) 2420 College Ave., Berkeley, Calif.

C. C. Gray, manager, harvester thresher and power machinery department sales, International Harvester Co., 606 S. Michigan Ave., Chicago, Ill.

N. Bernard Gussett, general superintendent, South Texas Department, San Antonio Public Service Co., San Antonio, Tex. (Mail) 201 N. St. Mary's.

G. E. Henderson, rural salesman, Dayton Power and Light Co., Wilmington, Ohio. (Mail) 525 N. Lincoln St.

C. V. Holman, manager, dairy equipment, wagon and engine sales, International Harvester Co., 606 S. Michigan Ave., Chicago, Ill.

Charles A. Keller, president and general manager, The Keller Manufacturing Co., Corydon, Ind.

Harry Leonhardt, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Vega, Tex.

R. M. McCroskey, manager, tractor and power unit sales, International Harvester Co., Chicago, Ill. (Mail) 7257 Pingree St.

Joel A. Wier, Jr., instrument-man, Georgia State Highway Department. (Mail) Royston, Ga.

Harold V. Wright, extension service, University of Georgia, Athens, Ga. (Mail) 1050 S. Lumpkin St.

Charles H. Zirckel, manager, tillage and seeding machine sales, International Harvester Co., 606 S. Michigan Ave., Chicago, Ill.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

CHARACTERISTICS OF COHESIONLESS SOILS AFFECTING THE STABILITY OF SLOPES AND EARTH FILLS, *A. Casagrande.* Jour. Boston Soc. Civ. Engin., 23 (1936), No. 1, pp. 13-32, figs. 5. Studies conducted at Harvard University are reported. The results showed that every cohesionless soil has a certain critical density, in which state it can undergo any amount of deformation or actual flow without volume change. The density in the loose state of many cohesionless soils, particularly medium and fine, uniform sands, is considerably above their critical density. Such materials in their loose state tend to reduce their volume if exposed to continuous deformation. If the voids are filled with water and the water cannot escape as quickly as the deformation is produced, then a temporary transfer of load on to the water takes place, and the resulting reduction in friction impairs the stability of the mass, which can lead, in extreme cases, to a flow slide. If a cohesionless soil is below the critical density, then it can stand any disturbance without danger of a flow slide. Whenever there is any tendency for the mass to deform, the water in the voids has a restraining influence. Many coarse-grained and very well-graded mixtures of cohesionless soils are in their loose state approximately at the critical density. This fact, combined with their large permeability, renders them relatively stable against any disturbances, even in the loose state. Cohesionless soils in a state above the critical density can be efficiently compacted, and thereby stabilized against any disturbances, by means of special vibration machinery.

THE RELATION OF POWER TO ANTI-KNOCK FUEL REQUIREMENTS FOR MULTI-CYLINDER ENGINES, *S. D. Rubenz.* Jour. Franklin Inst., 220 (1935), Nos. 5, pp. 615-656, figs. 14; 6, pp. 755-788, figs. 16. It is pointed out that when testing multicylinder engines under constant speed and load conditions the incaption of knock is best detected by the consequent rise in temperature of the cylinder head or cylinder walls.

A convenient arrangement for carrying out such tests on different engines, using a given fuel with various amounts of tetraethyl lead fluid added per gallon, is described, and typical results are reported.

The effects of various factors affecting the antiknock fuel requirements are considered in relation to simultaneous variations in power output. It is shown that complete separation of the phenomena due to these different factors is impossible, and the effects cannot be predicted but must be determined by the results of a series of tests for any particular engine.

It is also shown that the sensitivity of different fuels to the addition of ethyl fluid varies considerably even when they have the same original octane number. It is necessary, therefore, for a complete and reliable solution to the problem, not only to test each engine but also to determine the sensitivity of each fuel to the addition of ethyl fluid.

AN INVESTIGATION OF STRESSES IN PRESTRESSED REINFORCED CONCRETE PIPES, R. B. Crepps. Purdue Engin. Expt. Sta. Ser. 46 (1934), pp. 74, figs. 29. This bulletin presents the results of an investigation of the stresses produced in a recently developed type of prestressed reinforced concrete pipe when the pipes were being prestressed and when they were being subjected to internal water pressures.

The prestresses of greatest significance in this type of structure are the tension stresses in the hoop rods and the circumferential compression stresses in the concrete. The results of prestressing indicate that the magnitude of stresses measured on the surfaces of the pipes is related to the stresses in the steel rods. For the same unit steel prestress, the concrete circumferential compression prestress differs in the three pipes because of the different quantity of steel and the variations in the concrete used; however, from approximate averages, the compression prestress on the outside surface is 1.4 per cent of the hoop rod stress and on the inside surface it is 2.3 per cent of the hoop rod stress. The concrete circumferential prestress on the outside surface and that on the inside surface is 76 per cent and 124 per cent, respectively, of the average between them.

Internal pressure altered the stresses produced in prestressing by slightly increasing the initial tension prestress in the steel hoop rods and by decreasing the circumferential compression prestress in the concrete. The magnitude of the change in these stresses is dependent upon the magnitude of the prestress and of the internal pressure. For these pipes, a high initial steel stress, equal to more than 75 per cent of the elastic limit strength of the steel, could be used in prestressing without encroaching upon the elastic limit stress of the steel when the pipes carried maximum internal pressure; however, in prestressing, the stresses in both steel and concrete should be and were kept within the elastic range of the respective materials. The prestressed type of pipe is very effective in resisting external loads.

PHYSICAL PROPERTIES OF SPEED PORTLAND AND BLENDED CEMENT MORTARS AND CONCRETES, *R. E. Mills* and *R. B. Crepps.* Purdue Engin. Expt. Sta. Res. Ser. 47 (1934), pp. 60, figs. 39. This bulletin reports data on the more important physical properties of mortars and concretes manufactured from both a normal portland cement and a blended cement. The blended cement was prepared by blending three volumes of normal speed portland cement with one volume of Louisville natural cement. The physical characteristics of the two cements were studied in an extensive series of comparative tests, involving strength (tension, compression, and flexure), plastic flow, resistance to fatigue, expansion and contraction, durability, etc.

Little difference was found in the tensile strengths of the two cements for all ages up to 1 year. Slightly higher compressive strengths and modulus of rupture values were recorded for the speed portland cement as compared to the blended cement at all ages. However, this difference appears to decrease with advancing age, all values being within a range of approximately 9 per cent at the end of 1 year.

Measurements of plastic flow in concrete compression cylinders under sustained loads show that the blended cement exceeds the speed cement for all conditions of test by about 20 per cent.

The fatigue endurance limit of cement mortar beams, tested at the age of 28 days, was approximately 50 per cent for the speed cement and slightly higher for the blended cement. Similar tests conducted at the age of 4 months gave a fatigue endurance limit of about 51 per cent for speed cement and of 60 per cent for blended cement.

THE SIGNIFICANCE OF SIZE DISTRIBUTION IN THE CLAY FRACTION, *J. G. Steele and R. Bradfield.* Amer. Soil Survey Assoc. Bul. 15 (1934), pp. 88-93, figs. 2. The physical composition of profiles of Ellsworth silt loam and Miami silt loam is reported in an investigation carried out at the Ohio State University. Two methods of dispersion were used, namely, (1) treatment with sodium oxalate and (2) removal of bases by electrodialysis and saturation with sodium, added as the hydroxide. Each sample was stirred 15 minutes with a high speed stirring machine. By means of the pipette method the 5μ clay was separated into seven fractions on the basis of settling velocities. Four fractions were determined by gravity sedimentation, and three by means of the centrifuge.

The amount of the total clay was consistently higher, and the proportion of the finest fraction was lower, in the case of dispersion with sodium oxalate. In both profiles the surface horizons contained very little material of a radius less than 125 $m\mu$. In both subsoils, this fraction made up from 40 to 50 per cent of the total clay. The Miami subsoil contained 60 per cent of 5μ clay, one-third of which had a radius smaller than 31 $m\mu$. The Ellsworth subsoil contained 43 per cent total clay, (5μ), of which only one-fourth belongs to the finest fraction. Calculations of total surface showed that the ratio total—total surface per gram of soil/per cent of 5μ clay—was 20 per cent greater for the Miami B horizon than for the corresponding horizon of the Ellsworth soil.

It is suggested that all of the physical properties of soils "can be better interpreted with more complete knowledge of size distribution."

THE CALCULATION OF THE ANNUAL COST OF FARM MACHINERY AND IMPLEMENTS, *J. Wyllie.* Jour. Roy. Agr. Soc. England, 93 (1932), pp. 45-67. The proper method of ascertaining and apportioning costs, especially repairs, renewals, depreciation, and interest is discussed. *(Continued on page 496)*

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FACTORS INFLUENCING THE COOLING OF PACKAGES OF FRUIT, *S. D. Decker.* Amer. Soc. Hort. Sci. Proc., 31 (1934), pp. 153-156. With the aid of thermocouples arranged systematically throughout the package, temperature differentials were determined by the University of Illinois within baskets of fruit held in a chamber approximating the temperature of the refrigerator car. In the early stages of cooling relatively large temperature differences were found between the outer and inner rows of fruit. Using apples of different sizes, it was found that the size of fruit is not an important factor in the rate of cooling. The use of ventilated containers decreased the temperature differential between that within and without the package. Air velocities below 120 feet per minute had no influence on the rate of cooling of the contents, provided the temperature of the circulated air was constant. A drop of 12 degrees (Fahrenheit), in the internal temperature of apples followed immersion in water of a temperature between 51 and 52 degrees thus showing that cool water is much more effective in cooling fruit than is air of considerably lower temperature.

THE BIOLOGICAL EFFECT OF AVAILABLE PHOSPHORUS IN HAWAIIAN SOILS, *A. F. Heck.* Jour. Amer. Soc. Agron., 27 (1935), No. 10, pp. 847-851, fig. 1. The author of this contribution from the Wisconsin Experiment Station reports upon three plat experiments on which the fertilizers used were, respectively, 1,500 pounds per acre of sodium nitrate, the same plus 10 tons of waste molasses, and the same quantities of sodium nitrate and waste molasses plus 6 tons per acre of rock phosphate. The crop was sugarcane. The plats were located at the Waipio Substation of the Hawaiian Sugar Planters' Experiment Station.

"In the presence of available energy material, the biological activity in Hawaiian laterites is greatly stimulated by the presence of available phosphorus, when measured by the assimilation of nitrate nitrogen by microorganisms. In this combination with energy material, phosphorus helps prevent leaching of mineral nitrogen and also helps to build up a larger biological balance in the soil, which in turn increases the amount of phosphorus as well as nitrogen held in the organic form, thus increasing the availability of the phosphorus."

WIRE ROPE, *J. F. Howe* and *N. Carlson.* Jour. Boston Soc. Civ. Engin., 23 (1936), No. 1, pp. 33-39, figs. 2. A brief summary is presented of the fundamentals to be considered in any problem affecting the use of wire rope.

THE REACTIONS OF PLANTS TO ULTRA-VIOLET, *E. S. Reynolds.* Ann. Missouri Bot. Gard., 22 (1935), No. 4, pp. 759-769. This review constitutes a discussion of general considerations relative to the subject.

SOME EFFECTS OF RADIOACTIVE MUD UPON GERMINATION OF SEEDS AND GROWTH OF SEEDLINGS, *L. Havas.* Jour. Agr. Sci. [England], 25 (1935), No. 2, pp. 198-216, pls. 2, figs. 6. "Stimulatory effects upon germination and growth were observed in a very wide range of dosages upon exposing seeds and seedlings to the radiation from a radioactive mud of Hungarian origin. Emanation was not excluded, but interposed lead sheet practically abolished the significant differences. Stimulation was observed whether the seeds were placed directly in contact with, or at a little distance from, all but the largest amounts of mud. Treatment of seeds, before sowing, with the radiation from large amounts of mud for periods exceeding about 48 hours was harmful to germination and to growth; this harmful effect was more marked when the seeds were moistened.

"The degree and the kind of stimulation varied with the kind of seed and its history. Wheat seeds treated with vital stains showed responses to irradiation which appeared to depend upon the stain."

Book Review

SOIL EROSION AND ITS CONTROL, by *Quincy C. Ayres.* Cloth bound, 6x9 in, XI + 365 pages, 235 illustrations, indexed. McGraw-Hill, $3.50. A general text and reference bringing under one cover up-to-date information on soil erosion, and on its control by engineering and other means. Chapters cover Introduction, Factors Affecting Rate of Erosion, Methods of Control, Rainfall and Runoff, Terrace Design, Terrace Location-Principles and Practice, Terrace Construction Methods and Machinery, Terrace Construction Costs and Maintenance, Terrace Outlets, Control of Gullies, Temporary and Semipermanent Check Dams, Permanent or Soil-saving Dams, Special Uses of Vegetation, and Soil Conservation and Land Use. The appendix covers Simple Methods of Calculating Land Areas, Partial List of Soil Conserving and Depleting Crops, Partial List of Plants Favorable to Soil Conservation and Wild Life, Two-thirds Powers of Numbers, Square Roots of Decimal Numbers, Bibliography and Index.